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WORLD PETROLEUM

NEW YORK AND LONDON

APRIL 1939

ROUMANIAN OIL AND GERMAN EXPANSION

WILL COMPANIES ELIMINATE MARKETING LOSSES?

IRISH SOLUTION NEAR

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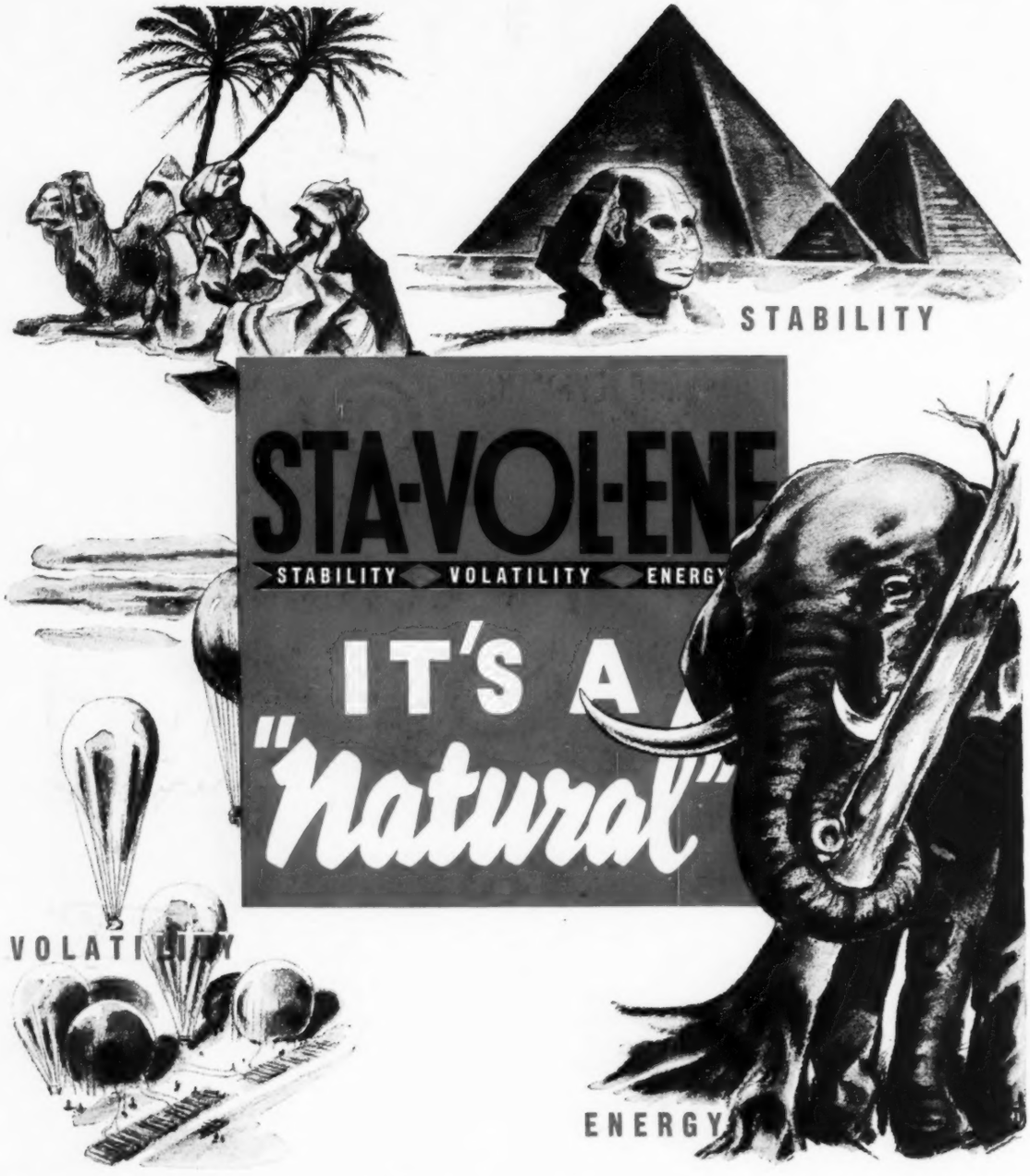

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WORLD PETROLEUM

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VOLUME 10 APRIL . 1939 NUMBER 4

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CORRESPONDENCE

ADDRESS all correspondence regarding subscription and business matters to the Home Office; 95 River Street, Hoboken, N. J.

Editorial and Advertising offices; 56 West 45th Street, New York, N. Y.
London office; 3 Savoy Place, Victoria Embankment, W.C.2.
Los Angeles office; 412 West 6th Street

SUBSCRIPTIONS

ANNUAL subscription to WORLD PETROLEUM is offered at the flat rate of five dollars (U. S.) postpaid to any country in the International Postal Union.

For the convenience of subscribers the publisher will accept payment in any of the following currencies at the fixed rate shown below:

Argentina	16 paper dollars
Canada	5.00 dollars
Colombia	5.55 pesos
France	105 francs
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Remittances or drafts should be drawn to the order of the Publisher, WORLD PETROLEUM, payable in New York and London.

Subscriber's name and address should be in Roman capitals on the subscription order.

Official position of subscriber is requested.

Advance notice, if possible, of a change of subscriber's address should be given.

AGENCIES

SINGLE copies of WORLD PETROLEUM are obtainable every month, within the delay imposed by the international mail service, at any of the following agencies:

CABIMAS, VENEZUELA—The German Store
BERLIN, 25, W. GERMANY—Verlag Chemie G.m.b.H. Corneliusstrasse 3.
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NEW YORK—Telephone Hoboken 3-2180 for list of 20 newsstands carrying copies.
PARIS—Librarie Brentano, 37 Avenue de l'Opera
PORT OF SPAIN, TRINIDAD—Davidson & Todd, Ltd., 8 Frederick St.
LOS ANGELES—412 West 6th St., telephone: Mutual 1391

The price of monthly copies is 2 shillings in countries of the British Commonwealth and the equivalent of 50 cents (U. S.) elsewhere.

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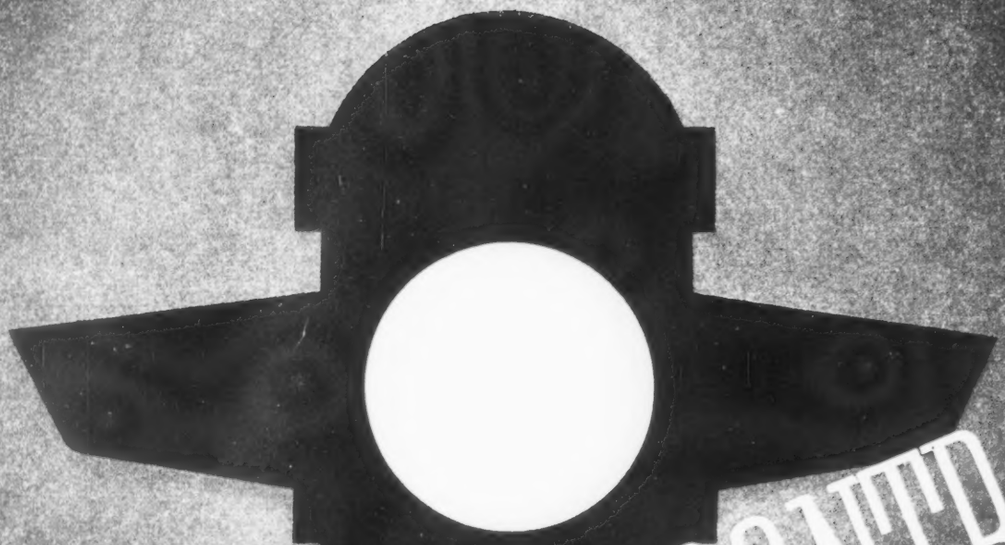

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EDITORIAL

DIPLOMATIC AND MILITARY STRATEGY BASED ON OIL?

EVENTS in Central Europe during the recent past are likely to have as profound an effect on world peace as they already have had on the map of Europe. The part now played by petroleum in diplomatic manoeuvers; the part it will play in military strategy, should war result, are of the utmost significance.

It is needless to reiterate the vital importance of petroleum in warfare. Twenty-four years ago it was credited with a major part in deciding the outcome of the World War. Military experts are aware of the decisive importance that dwindling petroleum supplies had in hastening the end of the Spanish Civil War. Today the major armies of Europe are motorized to an extent only dreamed of in 1914. Competent observers have expressed the opinion that the armed forces of Germany lead the world in the extent to which they are motorized; hence the importance of oil supplies to Germany may exceed that of any other country.

There are two principal channels through which oil can govern diplomatic and military strategy: in a positive manner, as a goal to be seized thereby strengthening trade position in peace time and military position in wartime; or in a negative manner as enemy supplies to be destroyed in wartime.

In taking over Austria and Czechoslovakia Germany added to her domestic production of 554,-163 tons the 64,157 tons produced in Austria and the 19,439 tons produced in Czechoslovakia. Austria, however, brought with her a consumption of roughly 316,000 tons and Czechoslovakia, a demand for about 314,000 tons. In peacetime, therefore, Germany would appear to have acquired only a demand for an additional 546,500 tons above the production of these two areas. Her own peacetime consumption being 7,571,430 tons, she already required 7,017,267 tons which has been supplied partly by production of synthetic products, partly by imports. The demand to be supplied in this manner is now, with the addition of the Austrian and Czechoslovakian balance of demand over production, 7,563,767 tons.

It seems obvious therefore that sooner or later German expansion must take the direction of including Roumania, either by peaceful trade penetration or by military seizure. With a production of 6,603,000 tons and consumption of 2,030,000 tons, Roumania would add not less than 4,573,000 tons to meet Greater Germany's demand amounting to 7,563,767 tons.

The words "not less than" are used advisedly: it must be borne in mind that while wartime demand would increase consumption figures substantially, German ingenuity, stimulated by her imperative need, would greatly increase the production in Austria, Czechoslovakia and particularly Roumania, while cutting down civil consumption by a tremendous percentage. This ability has already been displayed in a 40 percent increase in production in the Old Reich.

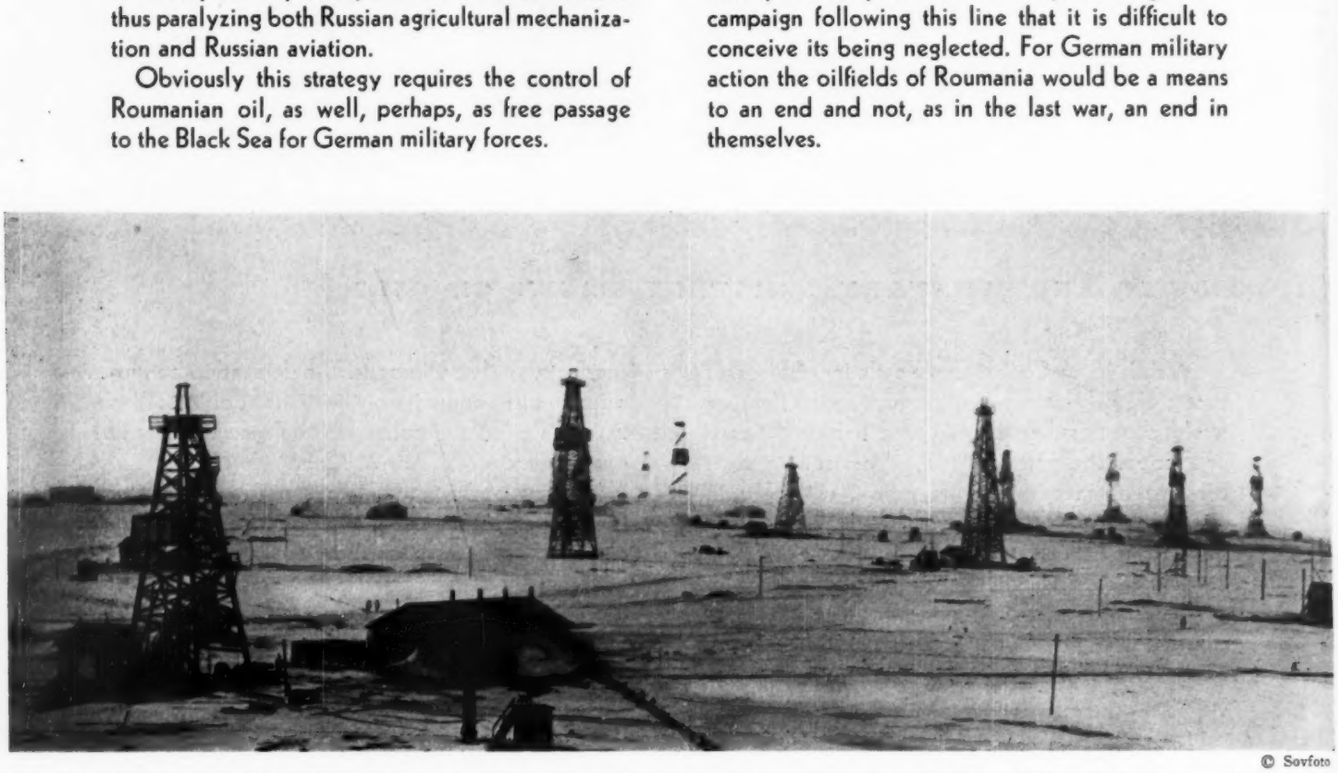
The second, more spectacular channel through which oil may affect military manoeuvers would be to bring about a military thrust by Germany aimed at Baku and Grozni for the purpose of paralyzing Soviet Russia's army while an attempt was being made to detach the Ukraine from the U.S.S.R.

This possibility has been suggested by no less an authority than H. Wickham Steed, former editor of The London Times and considered an expert on central European affairs. Writing in a special article for the New York Herald-Tribune on March 16th, Mr. Steed stated that an economic attache to the German Embassy in Moscow early in 1936 addressed to the authorities in Berlin a memorandum of great importance. It warned Berlin that any direct attack on Soviet Russia would be folly and that even if German forces entered the Ukraine they must not expect to be helped by the local popula-

tion. The only effective manner in which to penetrate the Soviet Union would be to get within striking distance of southern Russia from the region of the Black Sea. From there it might be possible to wreck, cut off, or capture the oilfields of Baku thus paralyzing both Russian agricultural mechanization and Russian aviation.

Obviously this strategy requires the control of Roumanian oil, as well, perhaps, as free passage to the Black Sea for German military forces.

The recommendation of the economic attache may long since have been shelved: German policy may no longer contemplate military action against Soviet Russia. Should military action be precipitated, however, there are so many advantages to a campaign following this line that it is difficult to conceive its being neglected. For German military action the oilfields of Roumania would be a means to an end and not, as in the last war, an end in themselves.



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Conscious of the dangers arising from such a concentration of petroleum supplies in so vulnerable a location as Baku, the Russians are busy trying to develop other oil bases scattered throughout the country: above, is shown the Sizran field between the Volga and the Urals where work is being pushed.

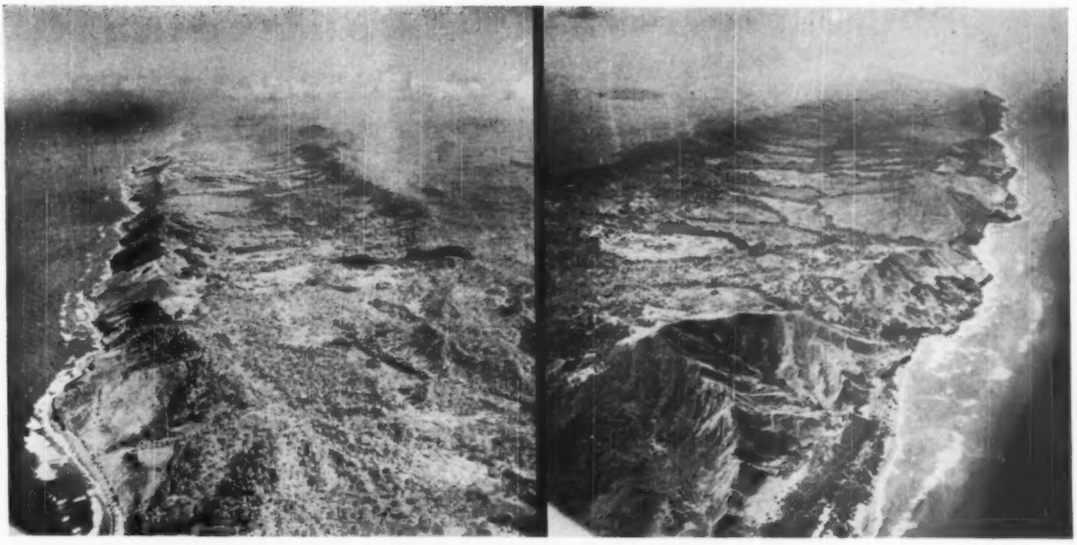
IRISH REFINERY Problem May Reach Early Solution

LONDON, APRIL 3, 1939

RECENT developments here and in Dublin point to the possibility of an early solution of the tangle that has enveloped the petroleum situation in the Irish Free State for the past two years. The difficulty arose from the grant by the Free State government of a refining monopoly to a company called Irish National Refineries, Ltd. Under the terms of this agreement the company would have the exclusive right to import and refine petroleum. This meant that distributors who had been doing business in Ireland for many years, including subsidiaries of Shell and Anglo-Iranian, Anglo-American, Texas and other companies would be forced to purchase their supplies from Irish National Refineries, Ltd. As purveyors of branded products such a requirement naturally was objectionable to these companies since they would have no control over the quality of the products dispensed and would have lost whatever advantage derived from the reputation established by their well-advertised brands. The companies protested and reports were published that they would withdraw entirely from the field rather than accept this stipulation in regard to their supplies. The response to this in official circles was that the monopoly, backed by the government, would undertake marketing as well as refining if necessary.

Irish National Refineries, Ltd., was organized in 1936 with a share capital of £1,000,000 and debentures of £1,000,000. It was a subsidiary of Parent Petroleum Interests, Ltd., in which the principal factors were T. J. C. Burgess, then chairman of London & Thames Haven Oil Wharves, Ltd., Lord Inverforth and William R. Davis. In 1938 it was announced that Davis had sold his interest in Parent Petroleum and had withdrawn from the company. The announced reason was that Davis' activities in Mexican oil, following the confiscation of oil company properties by Mexico, was embarrassing to the company, but Davis previously had stated to your correspondent that he disapproved the Irish refinery deal and regarded it as uneconomical.

Construction work on the site selected for the refinery, near Dublin, was begun in 1936 and contracts were let for part of the equipment. The original agreement called for completion of the plant in two years, but progress was delayed by strikes and apparently by financial difficulties and the time limit was extended. In February last



Two oblique aerial photographs of Oiapu anticline, Papua, where Papuan Apinaipi Petroleum Company, Ltd., has been conducting exploratory drilling for geological and palaeontological information prior to drilling a deep test. The view on the left is to the northwest and the other southeast. Launcelot Owen, geologist and general manager, states that the central valley is composed of petroliferous and fossiliferous mud-stone; the scarp faces running down into the central valley expose limestones, marls, and calcareous clays; and dip slopes consist chiefly of conglomerate.

the contractors engaged in installing power plant equipment withdrew their men and work was suspended. Even before that time doubt as to the ability of the holders of the concession to carry out their agreement had arisen in official circles in Dublin, though it was said that negotiations for financing were being carried on.

Connection with the proposed refining monopoly has had a disastrous effect on the fortunes of London & Thames Haven Oil Wharves Ltd. For many years it conducted a large and profitable oil storage business and its shares had a high investment rating. Following the announcement of the company's participation in the Irish monopoly scheme the Shell group discontinued its patronage of Thames Haven and established storage facilities of their own. Last year the Anglo-American followed suit. Meanwhile the company's investment in Parent Petroleum depreciated. Mr. Burgess resigned from the company in October last and Lord Inverforth retired the following month. Early in the present year a mortgage was recorded to secure the company's indebtedness to Lloyd's Bank and since that time the bank is understood to have had an influential hand in the direction of the company's affairs.

The report and statement of accounts of Thames Haven's directors for 1938, published March 29, shows net profit of £12,681 before provision of a guarantee of £28,539 on holdings of a subsidiary company. For 1937 the net earning was £203,767 after all charges. The financial statement shows a bank overdraft of £938,000 and reveals that the investment in Parent Petroleum Interests, Ltd., has been written down from £1,166,849 to £500,000.

In a frank statement accompanying the balance sheet figures the directors say:

"In September, 1938, at which time the overdraft at bank was £978,000, a critical position arose in the company's affairs. Financial difficulties, aggravated by the international tension, have necessitated a reversal of the policy outlined at the last annual general meeting regarding the Irish National Refinery. The Board decided instead to limit and, as soon as it is able to do so, to dispose of extraneous commitments and, while making the most of the company's assets, try further to develop the company's original business of wharfingering by the cultivation of friendly business relationships with its former customers."

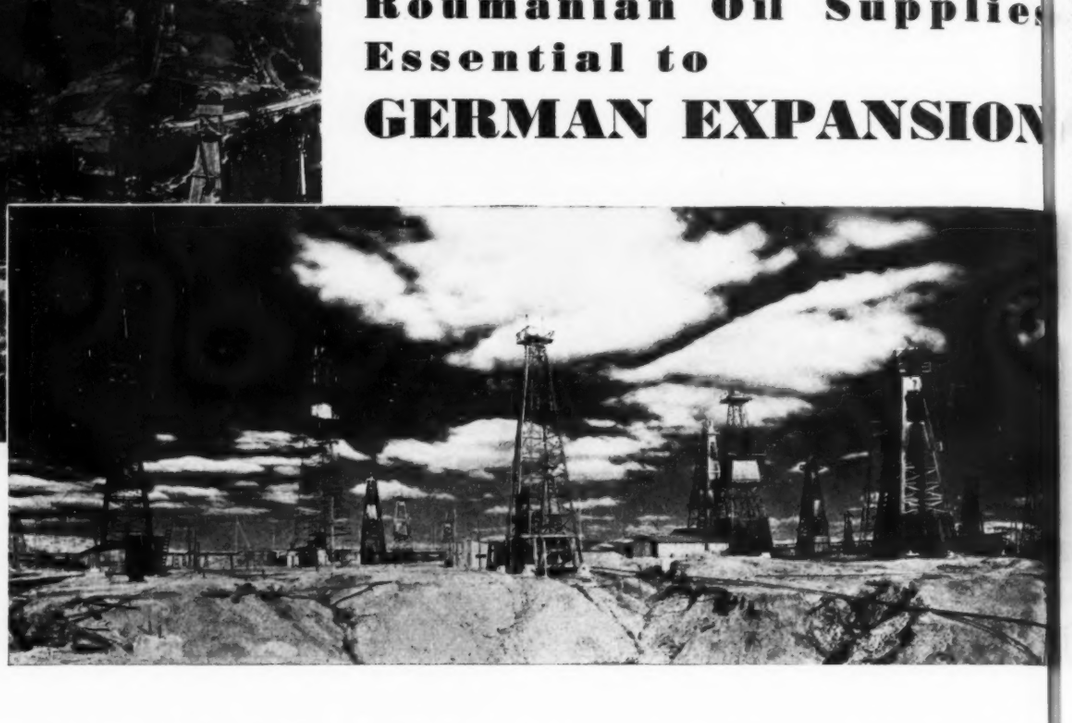
Declaration of the company's intention to dispose of "extraneous commitments" points to the early abandonment of the Irish renfiery enterprise and it is improbable that any other group would care to take on a project so discredited even if the Free State Government were disposed to go forward with it.

At the present time the Irish authorities are anxious to provide for increased petroleum storage as a measure of national defense. Abandonment of the refinery scheme will leave a site available for this purpose and it is considered not improbable that the oil companies now operating in the Free State market might be willing to come to an agreement with the government to maintain the desired quantity in storage on reasonable terms if assured that they would not again be threatened with the monopoly project which is now regarded as dead.

Whether such an outcome of the situation results remains to be seen. No statement on the subject has been issued and no negotiations between the government authorities and oil company representatives have been reported. In trade and financial circles, however, it is considered that some such agreement would be a fair and logical method of ending the Irish controversy and would lead to the establishment of amicable and stable conditions in that market.

The tanker Africa Shell which was recently completed for Shell Company of East Africa, Ltd., to operate between ocean installations at Mombasa and Beira and all the British Empire flying-boat service ports of call on the African coast. She will carry 560 tons of aviation gasoline on a draft of 11 ft., enabling her to get over the bars at the mouths of African rivers.

Roumanian Oil Supplies Essential to GERMAN EXPANSION



Old and modern drilling practice in the Roumanian oilfields; above, the Moreni field, and right, Gura Ocnitzei.

ONCE again oil has become the focal point of an international crisis. This time it is the oil of Roumania. On March 15 the Greater Reich swallowed the larger part of Czechoslovakia in one surprising gulp with even less fuss and confusion than attended the previous acquisition of Austria and the Sudeten areas. Politically, however, the repercussions were far more resounding. Every chancellery in Europe accepted as a fact what had been, until then, only a formidable fear. When the gray-coated Nazi legions began moving eastward from Prague it was recognized that they had started a march which, unless strongly opposed, would sooner or later extend German authority over the rich wheat lands of the Ukraine, the oilfields of Ploesti and possibly over even richer oil deposits in the Near East.

Roumania's importance in the oil world and, temporarily at least, in the world of high politics is due to the combination of its geographical position and its possession of relatively large petroleum resources. Aside from the Soviet Union the annual production of oil in Europe is roundly 8,000,000 metric tons. Of this amount over 80 percent is provided by Roumania. The country's preponderant position is accentuated by the fact that 70 percent of its oil is exported. Leaving Russia out of the picture it is the only European oil exporter of consequence. While Albania's oil is taken by Italy and a small part of Poland's production is shipped beyond its borders, the sum of these two movements is less than 100,000 tons per year while Roumania supplies to other countries some 5,000,000 tons annually.

Europe's position in the matter of production is shown concisely in the accompanying Table I which gives in metric tons the output of its oil producing countries over the past five years.

A second fact revealed by the table is that Germany, by more intensive exploitation and through its recent territorial additions, has enlarged its production by 40 percent. Production in Poland has remained relatively stable while other European countries play very minor roles as producers though Hungary is rapidly increasing its output and may be self-sufficient in the near future.

TABLE I

Production of European Countries in Metric Tons (Exclusive of the Soviet Union)

	1938	1937	1936	1935	1934
Roumania	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355
Germany, Old Reich	554,163	453,451	444,600	427,400	317,500
Germany, Ostmark	64,157	33,010	7,473	6,616	4,179
Czechoslovakia.*	19,439	17,936	18,665	19,946	25,971
Great Germany	637,759	504,397	470,738	453,962	347,643
Poland	504,678	501,301	510,630	514,760	529,200
Albania	72,166	88,310	32,760	6,152	2,500
France	72,106	71,008	74,788	74,172	98,025
Hungary	46,760	13,910	13	.....	.....
Italy	13,182	14,261	16,106	15,977	20,180
Total	8,587,410	8,850,584	10,279,773	9,912,985	9,818,546

* While Germany's authority thus far has not been extended to Ruthenia, the easternmost province of former Czechoslovakia, the amount of oil produced in that area would not affect the total materially.

As these figures indicate, Roumania's part in European oil production has declined, actually and relatively, in the past two years. At the beginning of the five-year period Roumania produced 89 percent of the total output while in 1938 this had fallen to 83 percent. The decrease of 2,000,000 tons since 1937 is not to be taken, however, as forecasting a failure of the Roumanian oilfields. It has been due rather to the heavy taxation and other burdensome requirements imposed upon petroleum producers by the government. This has discouraged exploration and the boring of new wells by making it unprofitable. A more liberal policy undoubtedly would result in a return of output to its former level.

Another interesting phase of the European situation is the matter of consumption. Statistics of consumption obviously are more difficult to obtain with complete accuracy than figures of production. Those contained in Table II represent the latest estimates to be published by competent authorities.*

While this tabulation omits some few of the smaller countries of Europe their consumption of petroleum products is so restricted that its inclusion would not affect the total materially. Taken in connection with the table of production it reveals

* Garfias and Whetsel before A.I.M.M.E. February 1939.

that with the exception of Poland and Roumania no European country in the list is able to satisfy its requirements in the matter of petroleum. As a point of interest to those who view the subject from the political angle, it is noteworthy that addition of Roumania's surplus to its own production would approximately meet the ordinary commercial needs of Greater Germany.

TABLE II.

Consumption of Petroleum Products (In Metric Tons)

	1938	1937
Germany, Old Reich	7,571,430	6,471,430
Ostmark		314,300
Czechoslovakia	314,300	471,430
Great Germany	7,885,730	7,257,160
United Kingdom	13,257,000	12,274,300
France	6,857,140	6,214,300
Italy	3,000,000	2,857,000
Roumania	2,030,000	1,803,000
Netherlands	1,564,300	1,485,700
Sweden	1,300,000	1,271,430
Belgium	957,140	950,000
Denmark	935,700	864,300
Norway	693,000	685,700
Spain	570,000	730,000
Switzerland	495,700	467,000
Poland	478,570	400,000
Greece	355,700	340,000
Irish Free State	335,700	323,000
Finland	281,570	270,000
Hungary	280,000	275,700
Portugal	218,570	214,300
Turkey	168,170	164,300
Total	41,663,990	38,847,190

While Europe's peace time demands for petroleum above its own production, amounting roundly to 33,000,000 tons, are readily met from a variety of sources including the Near East, the Far East, the United States and South America, the situation in the event of war would be entirely different. It is this possibility of war, always present in the minds of political leaders, that gives to Roumanian oil its great strategic importance. Great Britain and France could continue to obtain petroleum supplies from across the Atlantic or from the East via Cape of Good Hope, even though established trade routes through the Mediterranean were blocked. For Central and Southern Europe, however, the prospect in case of war is less assuring. Germany in particular is exposed to the danger of having its ocean borne supplies shut off through a blockade of North Sea and Baltic ports. With Italy as an ally some oil might find its way to Germany through that country but even Italy might find its water approaches blocked.

From a military viewpoint, therefore, it becomes of supreme importance to Germany to assure itself of oil supplies obtainable by land or river transport. In view of existing relations between Germany and the Soviet Union the only available source of such supplies is Roumania or to a less extent Poland. The situation so obviously makes it in Germany's interest to maintain access to Roumania's oilfields either through economic arrangements or by actual political control that no well informed political observer doubts that it is part of the scheme of German expansion to acquire domination of Roumanian supplies. This need not necessarily be accomplished by force. Immediately following the absorption of Czechoslovakia, Germany and Roumania concluded a five year commercial agreement which not only will bring about a greater interchange of goods between the two countries but also provides for a German-Roumanian company to engage in search for oil.

Roumania's exports by countries of destination during 1937 and 1938 are given in Table III, the figures being in metric tons as published by the *Moniteur du Petrole Roumain.*

TABLE III.

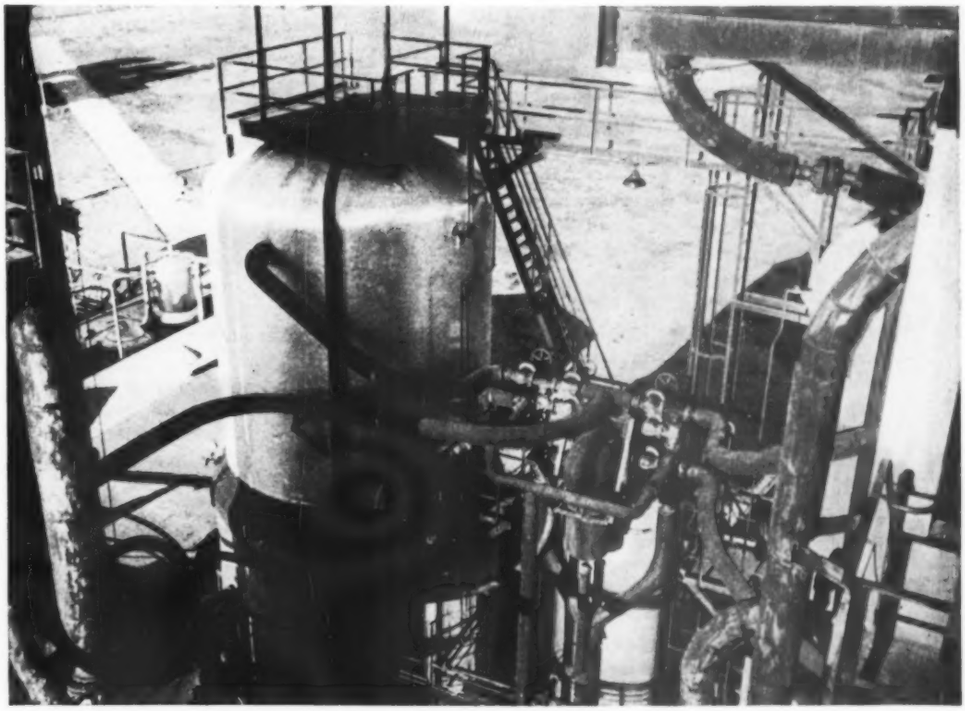
Exports of Roumanian Oil by Countries

Country	1938	1937	Increase or decrease percent
Germany	692,654	435,281	+ 59.1
Italy	556,535	575,800	— 3.3
United Kingdom	549,227	580,182	— 5.3
Czechoslovakia	294,887	351,131	— 16.7
Egypt	283,305	278,884	+ 1.6
France	289,338	603,868	— 52.1
Greece	200,215	249,244	— 19.7
Hungary	198,078	288,411	— 31.3
Spain	142,853	229,351	— 37.7
Other countries	938,472	1,588,447	— 40.9
Ships bunkers	357,867	484,738	— 26.2
Total	4,503,431	5,665,337	—172.5

Great Germany, including Czechoslovakia, thus provided a market for 22 percent of Roumania's exports in 1938 while Italy took 12.3 percent and Great Britain slightly less. British official figures in fact put the decline in Roumanian imports from 1937 to 1938 at approximately 38 percent instead of 5.3 percent as shown by Roumanian export statistics. French purchases from Roumania fell off over 300,000 tons and France's share in the total business declined from 10.6 percent in 1937 to 6.4 per cent in 1938. The Roumanian oil trade has been directed more and more largely toward Germany and Italy instead of toward more distant markets. This has taken place despite the fact that the capital invested in Roumanian oil production, outside that of native firms, has come mainly from Dutch, English, Franco-Belgian and American groups.

The figures given in the accompanying tables refer in all cases to peace time requirements based mainly upon industrial activities. In case of a general European war these requirements would immediately be doubled or tripled even though the civil use of petroleum products were to be drastically curtailed. Estimates by well-informed observers have placed Europe's probable wartime demand at 70,000,000 tons or more in addition to its own production. Germany, with its present area, probably would require not less than 15,000,000 tons. Controling Roumania's fields her position, while difficult, would be far less desperate than it might become without access to these rich supplies. It is this consideration that is causing the men who deal with international politics to concentrate their attention and their manoeuvres on this small part of Eastern Europe at the present time. They realize that control of Roumanian oil may decide the fate of nations other than the one that produces it.

Clay treating installation at the refinery of Credital Minier at Brazi, Roumania.



Will Companies Eliminate Marketing Losses—BEFORE GOVERNMENT DOES?

By Paul Ryan and Edwin L. Kennedy

Some Integrated Companies Make 37 Per Cent Net Profits from Refining-marketing. — Governmental Regulation May Force Other Companies to Imitate, Unless They Stop Their Own Losses First.

RECENTLY governmental officials have emphasized their desire to create another breathing spell for business with a reduction of governmental pressure, a lightening of taxes, and removal of some of the inhibitions which have curtailed the freedom of business development.

One industry which could materially benefit from this "appeasement program," as some have styled it, is the oil industry. Controls have been placed upon industry which, Senator Tydings and others feel, are "unwise as a matter of national policy because these various measures, added one by one, arrive at the goal of State Socialism."

There are many courses which the government can pursue to correct some of those activities which experienced and mature judgment have shown to be detrimental to the industry, and unprofitable and unwise for the government. The imposition of REASONABLE taxes, the elimination of punitive taxes, the removal of those threats of punishment for actions which are concerted in character, but legal and beneficial for the industry and the consumer—all of these are matters which the federal and state governments might wisely review.

Some of these subjects are:

1. Taxes of five cents or more per gallon on gasoline cannot be considered reasonable when the oil company itself receives less than five cents for having its geological, land, lease and legal departments discover and prove the land, for having its production department obtain the oil, its pipeline department transport it, its manufacturing department make the gasoline and load it into tank cars. A tax of more than 100 percent on the manufacturer's gross sales price cannot be considered reasonable taxation in any industry.

2. Chain store taxes and other forms of punitive taxation not only hamper the development of economical methods of distribution, but definitely increase the cost of the products to the consumer. In the oil industry such taxes have resulted in an alteration in methods of distribution, which leaves the price control for the retail distribution of the petroleum products in the hands of those who may not be fully appreciative of their costs of operation, and who too often lack the facilities and experience for the assumption of the necessary leadership in retail marketing. Such a condition can prove nothing but detrimental to the interests of the consumer and of the government.

TABLE 1*

Investment in U. S. Oil Industry By Divisions

Division of Industry	Dollars Invested	Percentage of Industry's Dollars
Production	$ 5,665,000,000.	42.7
Pipe-line	941,000,000.	7.1
Refining	3,670,000,000.	27.6
Marketing	3,000,000,000.	22.6
	$13,276,000,000.	100.0

3. To these taxes are added the usual taxes incurred in the management of any corporation, and common to all industry. These, too, (doubled since 1929) present an added burden which governmental authorities might well look toward lightening.

4. The recent governmental litigation against companies and executives in the oil industry has produced an aura of fear within the industry which can produce little benefit for the industry, the consumer or the government. The result is that an industry such as the oil industry, which necessarily demands cooperative enterprise for its successful operation, now lacks those discussions which can produce beneficial results. On the statute books, there are ample laws to punish those who abuse the freedom of such concerted action; the threats of governmental action, however, impinge on all with such force that even constructive cooperation is inhibited.

5. The flood of crude oil production which, under present circumstances, is being regulated with the greatest of difficulty, is producing a tremendous burden for the industry which could well benefit by some form of permissible concerted action.

6. The tank-car price for gasoline, which is such a basic foundation for the entire price structure of the gasoline, is too susceptible to the fluctuations caused by the unorganized selling of small amounts of unbranded gasoline; here, too, benefits could be accomplished by some permissible concerted action within the purview of the law.

7. The present maladjustment between the selling price of the crude oil and the selling prices of the refined products, arising from the quasi-political aspect of crude production and the restraint on adequate leadership in the marketing of refined products, precipitates a serious problem. This could be materially helped by some permissible concerted action, which would allow profitability in the manufacture of petroleum products without proportionate increases in the consumer's purchase price.

8. The entire distribution structure for petroleum products could be benefited by an intelligent relaxation of the government's excessive controls; the mere distribution of gasoline within a local area costs the consumer approximately six cents per gallon, whereas the total production of the crude oil and the manufacture of the refined product costs one and a half cents less. The correction of inequities, such as these, could wisely be accelerated by the government pursuing a course of reasonable regulation.

TABLE 2*

Income of the Petroleum Industry by Division and by Years

Year	Production Gross Profit (Unit $1,000.)	Percentage of Industry's Net Profits	Pipe-line Net Income (Unit $1,000.)	Percentage of Industry's Net Profits	Total Profit Production & Pipe-line (Unit $1,000.)	Percentage of Industry's Net Profits	Net Profits of Industry (Unit $1,000.)	Refining & Marketing Profit or Loss (Unit $1,000.)	Percentage of Industry's Net Profits
1927	$198,948	190.0	$ 93,239	89.3	$291,687	279.2	$104,384	d$187,163	——
1928	171,280	44.3	117,206	30.3	288,486	74.6	386,516	98,030	25.3
1929	352,563	77.2	142,216	31.1	494,779	108.2	456,495	d 38,284	——
1931	d120,853	——	120,738	——	d 115	——	d333,903	d333,788	——
1932	128,766	——	112,362	——	241,128	——	d182,400	d423,528	——
1933	62,490	30.6	105,943	51.9	168,433	82.6	204,000	35,567	17.4
1934	287,857	108.8	84,143	31.9	372,000	140.8	264,000	d108,000	——
Average	$154,342	120.2	$110,836	86.0	$265,216	206.2	$128,434	d$136,744	d106.2

d means deficit. * Data through courtesy of Edwin L. Kennedy, New York:—"Oil Attains Prosperity," November 28, 1936. Reproduced from World Petroleum, December 1937—"Can Marketing Produce More Profits?" by Paul Ryan.

The continued unprofitable operation of the oil industry through burdensome taxation, excessive over-production of raw material and unsound distribution methods forced upon the industry by its inability to pursue cooperative measures, will inevitably result in an industry that can prove of little benefit to the government as a source of any revenue; an unprofitable industry is a liability to government.

There is undoubtedly much to be hoped for from the statements of governmental officials regarding the government's aims to assist business; the oil industry offers broad opportunities for the sincere and practical application of these promises. Time alone can give them actuality.

In the meantime, it strongly behooves the companies in the industry to examine their own operations and, of their own volition, correct those operating procedures which are uneconomical, unsound, and unprofitable, before further study by the government may cause the government not to relax its controls but to intensify them. There is much that the government can do to assist the oil industry in providing a more economical distribution of its products to consumers; there is much also which the companies themselves can do to achieve this same objective.

Recently at the request of the Temporary National Economic Committee (on Monopolies) Assistant Secretary of State Adolf A. Berle, Jr., submitted a memorandum outlining his views on the subject. In this memorandum Mr. Berle says:

"The investigation of business organization and practices (frequently called investigation of monopolies) should be essentially a search to find an organization of business that actually works."

Mr. Berle suggests as yardsticks, for determining a proper economic organization, the measurement of results, principally whether that organization efficiently supplies the needs of individuals and whether it produces profits for those engaged in it.

Summarizing these observations, Mr. Berle states that:

". . . The investigation should be a search for an organization of business that actually works . . . . whether it supplies the public's wants . . . . whether there is an adequate supply of goods . . . . whether the distribution system supplies these wants with a maximum efficiency to the maximum number of people . . . . whether the system provides an adequate living—good wages and good profits—to those engaged in it."

In the balance of his memorandum, Mr. Berle continues to emphasize that factual studies must be made to determine the type of organization that actually can work, and then outlines various measures which could be adopted by the government to help companies and industries achieve the type of business organization that actually does work.

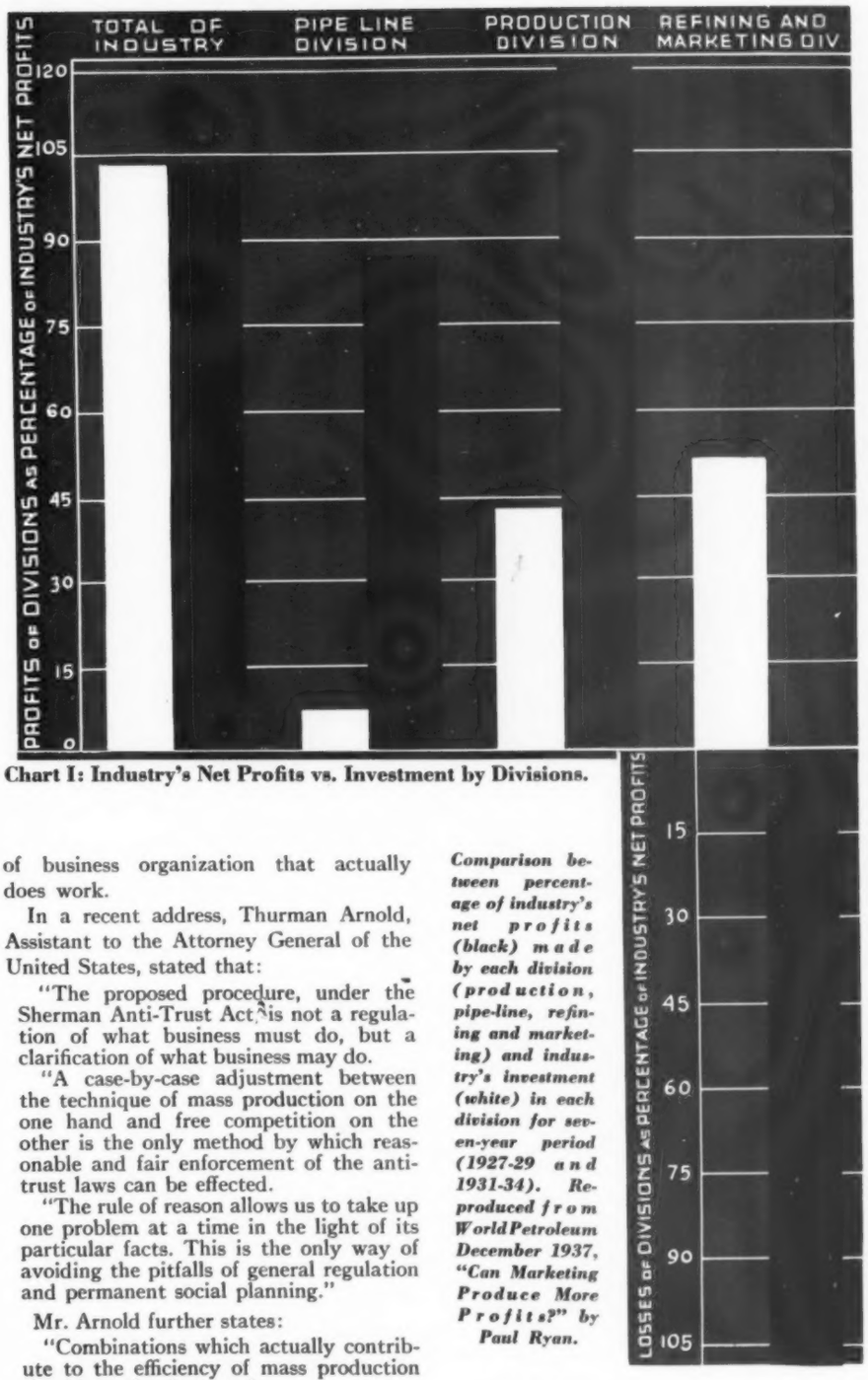


Chart I: Industry's Net Profits vs. Investment by Divisions.

Comparison between percentage of industry's net profits (black) made by each division (production, pipe-line, refining and marketing) and industry's investment (white) in each division for seven-year period (1927-29 and 1931-34). Reproduced from World Petroleum December 1937, "Can Marketing Produce More Profits?" by Paul Ryan.

In a recent address, Thurman Arnold, Assistant to the Attorney General of the United States, stated that:

"The proposed procedure, under the Sherman Anti-Trust Act, is not a regulation of what business must do, but a clarification of what business may do.

"A case-by-case adjustment between the technique of mass production on the one hand and free competition on the other is the only method by which reasonable and fair enforcement of the anti-trust laws can be effected.

"The rule of reason allows us to take up one problem at a time in the light of its particular facts. This is the only way of avoiding the pitfalls of general regulation and permanent social planning."

Mr. Arnold further states:

"Combinations which actually contribute to the efficiency of mass production should not be destroyed.

"Concerted action on the part of groups of competitors in order to insure orderly marketing conditions should not be considered unreasonable."

It is a moot question whether these quotations from the public statements of leading New Dealers indicate that the government is becoming more tolerant toward those organizations of business which actually produce benefits for the consuming public and, simultaneously, produce reasonable profits for the operating company.

If Mr. Berle's thoughts are indicative, the Monopoly Investigation undoubtedly is looking toward the creation of "the type of organization that actually works" in an industry—one that uses a distribution system which benefits the public and, simultaneously, enables the distributing company to operate at a profit.

The definition of such yardsticks by the Monopoly Committee and the enunciation of such a rule of reason in anti-trust actions would be most welcome, because the oil

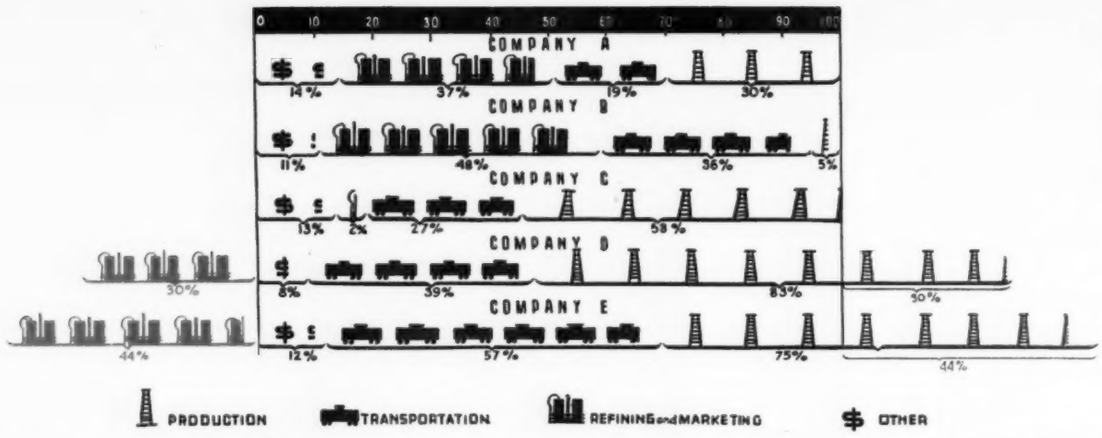


Chart II: Companies' Net Profits by Divisions. Comparison of percentage of net profits obtained by operating divisions of five major oil companies in 1937. Red symbols indicate losses.

industry can well point with pride to its accomplishments in meeting successfully the challenge of the consumer to supply him with petroleum products anywhere in this country, at an increasing rate that staggers the imagination, and at a constantly decreasing price. That is an accomplishment that few other industries have ever even approached.

Unfortunately, however, the oil industry would suffer from such a yardstick, because the industry has not been able to devise procedures which give this service, and still allow the companies to make a profit from the service. Many of the companies have annually produced a continuous supply of crude oil—for someone else to process and sell to the consumer at a profit; too frequently, whenever the producing company tries to distribute its own products, it does an inefficient, costly job which yields only losses to the stockholders.

Investment bankers and individual investors, upon whom the industry must depend for its capital, are realizing, with increasing clarity, that such distributing services are so elaborate and costly that they are not able to pay their own way, but are being financed out of the investors' capital, or from the current earnings already existing as profits from other operations of the company.

These bankers and investors contend that such a situation is unsound not only from the public's point of view, but quite definitely from the point of view of the companies, who cannot permanently continue to finance their marketing services out of their capital or by subtracting profits from other services. Fortunately, some few companies are taking corrective measures; they would survive Mr. Berle's yardsticks; but, regrettable as is the admission, the majority of the industry would fail.

Mr. Herbert Hoover recently pointed out several examples where, after periods of unprofitable operation of industries resulting from a combination of uneconomic policies of management and some regulatory measures by government, the investors and the government joined to advocate increased governmental control to save the industry and the investors' stake in it. With such precedents, the oil industry should exercise caution.

Perhaps the more optimistic among us might include the oil industry as among those industries which could consider themselves within the purview of the rule of reason as announced by Mr. Arnold, which permits the existence of those combinations "which contribute to the efficiency of mass production and which insure orderly marketing conditions." The indefiniteness of the intentions of the government, however, tends to promote a feeling of insecurity; under such conditions, the oil companies might well look toward bringing about, of their own volition, an improvement in conditions within the industry, which would produce greater benefits for the stockholders, the managements of the companies, and their employees, their dealers, and the consumers.

On the one hand there is the much publicized appeasement program: on the other, investigations with present and proposed litigation. The result is complex and confusing to the industry. Because of the latent threat of governmental supervision, however, to enforce the involuntary adoption by all companies of those procedures which some companies have voluntarily adopted and proven successful, the questions naturally arise:

A. "What are most of the oil companies doing to help themselves, so that they, like some other industries, will be given 'a clean bill of health?' "

B. "What constructive steps are the individual oil companies taking in their own behalf to avoid the necessity of governmental supervision?"

C. "What procedures are these companies evolving to assure their stockholders and their employees and the general public that they are using, as Mr. Berle states, 'efficiency in meeting the needs' for their products?"

D. "Are these companies really making profits in some parts of their operations, and hoping that these profits will ultimately counter-balance the losses in other parts of their operations?"

In the December 1937 issue of WORLD PETROLEUM, in an article entitled "Can Marketing Produce More Profits?" we used data from the reports of the oil companies themselves to the United States Tariff Commission, to the Interstate Commerce Commission, and to the Petroleum Administrative Board which showed that, over a period of years, the pipeline and production divisions of the industry made a net profit equal to 206 percent of the net profit which the industry finally attained, but that the refining and marketing divisions made losses equal to 106 percent of the total net profits of the industry. In other words, if the refining and marketing divisions of the industry would merely "break even," profits of the oil industry would double. These data for the industry as a whole are shown in Tables I and 2 and Chart I.

Unfortunately, too many companies in the oil industry do not seem to have felt the pinch of necessity, which would cause them to identify and correct their troubles. Other companies in other industries have been forced to change their operating procedures in order to make all of their operations show satisfactory profitability. But the oil industry has been enabled to obtain satisfactory profits from the production and transportation sides of its business; these profits, made by the sale of their crude oil to others, have been adequate to cover the losses sustained, when these same companies processed and distributed the balance of their crude products through their own refining and marketing divisions.

The deplorable situation is that many of the integrated companies have not chosen to use the same analytical thinking and constructive action on marketing problems as they have so successfully used on production problems, and have, therefore, continued to operate their marketing departments at repeated losses, while the smaller companies, who lack many of the facilities of their larger competitors, buy the crude from the larger companies, process it, and market it at a profit. And these smaller companies continue, year after year, to make money for their stockholders solely on their refining-marketing functions, or even on marketing alone.

Recently a chief executive of one of the major companies stated:

"Our sales department exists solely as an outlet for our production of crude oil. It is not supposed to make a profit; it is supposed only to find a market for our production of crude oil."

This very same company, however, makes over 70 percent of its net profit from its sale to others of a third of its crude oil production and purchases, whereas on the two thirds of its production and purchases which it puts through its own refining and marketing facilities, it barely makes a profit. If this company were forced, by some unfortunate circumstance, to put 100 percent of its production and purchases entirely through its own refining and marketing facilities, it would encounter serious losses—or correct its present unsound marketing policies.

Obviously, such companies are using their marketing facilities not as outlets for their production of crude oil, as this executive states, but merely as outlets to dispose of the excess crude oil which they cannot sell to others to refine and market.

The annual reports of the companies, their reports to the Securities and Exchange Commission, and other public information show that some few companies made profits on their 1937 refining and marketing operations—and did so, for the preceding two or three years (1937 reports provide the latest available data).

These successful companies are not limited to any particular size, or any particular type of operation; big companies, medium-sized ones, and small companies have proven that they can make profits on their refining and marketing operations.

Nor is the possession of the facilities for the production of crude oil a necessary condition for making profits from refining and marketing; some of these companies buy all of their crude requirements, some buy two-thirds, some buy half, some are sellers of crude. For example, Standard of Indiana, in its own marketing territory, made an average net profit, before Federal taxes, from its refining and marketing operations *alone*, of over nine percent of its sales during the years 1936 and 1937—and Standard buys two-thirds of its crude supply.

Among these successful companies are Standard of Indiana, Texas Company, Standard of California, Phillips, Sun, Continental, Standard of Ohio, Ohio Oil, and a few others. These companies have proven that it can be done; and they have further proven that it does pay.

In the article in the December 1937 issue of WORLD PETROLEUM above referred to, a comparison was made between oil companies' gross sales, operating expenses, financial charges, and net profits. Some observant analytical executives pointed out that the net profits included profits on crude production, as well as on all other operations of each company; their analysis was correct, since separate data on marketing profits (or losses) were not available.

Here below, in Table 3, are presented for the first time in print, for five major integrated oil companies, comparisons showing the percentages of their net profits produced by the separate divisions of the companies. These data have been combined by us into their present form; they have been drawn from the reports to the Securities and Exchange Commission and other public sources, and are therefore deemed reliable.

Company A is a large company, with sales from $200,000,000 to $400,000,000 per year; Company B is medium-sized, with sales from $100,000,000 to $200,000,000 per year; Company C is small, with sales from $50,000,000 to $100,000,000 per year; D and E are large companies, with sales from $200,000,000 to $400,000,000 per year. All

TABLE 3

Comparison of Percentages of Net Profits Attained by Operating Divisions of Five Major Oil Companies

Divisions	Companies				
	A	B	C	D	E
Production	30	5	58	83	75
Transportation	19	36	27	39	37
Refining & Marketing	37	48	2	d30*	d44*
Other	14	11	13	8	12
	100	100	100	100	100

*Loss

of these companies are major integrated companies with securities listed on the New York Stock Exchange. None of these companies will be identified until such time as they choose to publish such data about themselves.

What have those companies done, who have made profits on their refining and marketing operations, to identify the causes of their losses and to correct these conditions? There have been varied approaches to this problem, but, in general, they have recognized that they must coordinate all of their operations, and that they must plan to utilize their facilities intelligently to produce the most profitable sales with the least expense.

Several of these successful executives have catechized themselves as follows:

A. Are we marketing our products where there is an adequate potential business, or are we concentrating our efforts in those areas where the total volume of business is low?

B. Are we getting our profitable share of the business, or are our operating costs too high, because we have too small a percentage of the business spread over too wide an area? Conversely, are our costs too high as a result of trying to hold an inordinate share of the business?

C. Is our business properly divided among the most profitable channels, or is too high a percentage of our sales in commercial business, and too low a percentage in the consumer business?

D. Are we giving away too much of our stockholders' money in the form of concessions, to get dealers to handle our products, so that they make their profits by BUYING our products from us, instead of by SELLING our products to the public?

E. Are we using intelligent means of mass-selling to MANUFACTURE CUSTOMERS for our dealers, in the same way that we manufacture our products for them? Do we realize fully that the only one thing we can really give a dealer is our customers, when he agrees to handle our products for us?—And that, although the dealer can buy comparably good products elsewhere, he can get our customers only through us?

F. Are we utilizing sound principles of selective selling to select and develop good dealers in well-chosen areas with good potential, and do we help them to help themselves to make profits for themselves and for our company, or do we pick them at random, when, as and if we can get them, and then leave them to their own devices?

Do we allow them reasonable margins per gallon and help them build their gallonage to satisfactory levels, or do we constantly keep them dissatisfied by reducing margins and increasing their rents, and diluting their gallonage per outlet by multiplying "competitive" outlets handling our brand?

Do we dump our stockholders' money into outlets of questionable profitability and then keep the investment and the current expense there, long after it has proven it can never become profitable, or do we really have the courage to reduce losses and save the investors' money by consistently following a wise policy of "Pull or Sell?"

And do we really say to the dealer—and mean it—"Mr. Dealer, you need 5000 gallons of gasoline and proportionate quantities of a balanced line of motor oil, tires and accessories to break even. At the end of sixty days from now, we hope you are breaking even. If you are not, we will pull our equipment from your station, or we will sell it to you for cash." Do we say it, and mean it, and leave such unprofitable business for our competitors or do we continue to hang on, and increase our losses?

G. Are we making all of our sales experience readily available to the dealers by training them as completely as possible to sell our products in the one best way, which our experience has developed, or are we letting each dealer use methods of his own limited creation to sell our products in our name to our customers?

Thurman Arnold, assistant U. S. attorney general, addressing the National Press Club.

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H. Are we continuously training all our sales personnel, from the highest to the lowest, so that they are competent to supervise dealers and all others under their authority, and have we set up our procedures so that they do constantly supervise all dealers and others in the most profitable way of marketing our products?

Are we continuously training our own sales personnel so that they are always ready to accept increased responsibilities and authority, whenever the opportunity for promotion offers? Do we have adequate supplies of trained personnel available, so that we could truthfully apply the thought, "When the president of our company dies, everybody moves up one rung, and we hire a new office boy?"

I. Are we stimulating and enthusing, by intelligent sales promotion means, our sales personnel and our dealers to want to sell our products most profitably, and to want to tell our sales story to the public most effectively, or do we let them remain apathetic and listless, and trust that their self-created interest in our plans will be sufficient to make them enthusiastic?

J. Are we properly taking the fullest advantage of the opportunities for public relations work, to have our sales personnel and dealers and other employees make beneficial personal social contacts with the consuming public, and produce a volume of good-will and patronage that we can achieve in no other way?

K. Are we completely coordinating all of our operations, so that our sales promotion, advertising, public relations, personnel training, and our other sales functions are all intimately geared together running at the same speed to produce the one common result, or do we have disjointed, unconnected sales efforts, going out from our various departments, through our sales divisions to our dealers, where the burden is finally placed on the long-suffering dealer to coordinate all of this work, which should have been coordinated by us in our head office.

L. Are we helping our distributors and agents and dealers to make adequate profit by doing aggressive constructive selling of a balanced line of motorists' needs, or do we employ our distributors and agents primarily to conduct subversive marketing activities, for our temporary benefit, which we would not do ourselves? Do we utilize distributors and commission agents only in those poor areas of reduced profitability, where we challenge them to make profits, which we admittedly could not make ourselves?

Do we expect our distributors, jobbers and dealers to operate on margins less than the amount required for us, with all our experience, ability, and facilities, to do the same job? Can we say that we pay them what it would cost us to do the same job, or would our costs need to be reduced to compare with the margins we allow them?

M. Does our company operate as one unified entity, as it appears to be to the stockholders, the employees, and the public, or do we allow our various marketing divisions to create and operate plans for contacting our customers so that each of the dozen divisions tells a different story about the identical subject—our company and its products—thus adding greatly not only to the expense of operations but to the confusion of the public?

N. Does our company make acceptable grades of petroleum products, which are based upon a desire to give the public what the public wants, as learned from continuous consumer surveys? Have we really rationalized the need for having multiple grades of the same product, or have we just blindly followed the lead of some competitors? Have we analyzed the cost of handling these multiple grades of the same product, which, in many cases, because of their small volume, result in an expense of distribution which greatly exceeds their manufacturing cost? What would we lose in gallonage and gain in reduced expenses and increased profits by eliminating some of the costly extra grades?

O. Are prices for our products reasonable? Is our price scale so set that we make a profit, and at the same time adequately compensate our employees, our distributors, and our dealers as they intelligently perform their share of the distributing process?

Are our prices reasonable to the consumer? Have we became so supersensitive to the imaginary effect of reduced price by our competitors that we glibly slash our prices, thereby nullifying the beneficial effect of economies in our other operations, and throwing away the profits that are due to our company's investors and its employees?

Do we maintain reasonable prices to the consumer, while simultaneously giving excessively long margins to our dealers, thereby penalizing all the others in our distributing set-up and denying to the consumer the benefits of mass production, achieved in the other departments of our business?

P. Are we sweating and straining to save a few pennies in the manufacture of our products, and then wasting dollars in the distribution of them by following policies of "more gallonage at any price?" Do we cut prices further below their already low levels to try to expropriate business in areas in which existing companies are already suffering from too much competition? Do we continue to dilute further our dealers' business by duplicat-

ing our own outlets, and thus increase our costs and our losses?

Q. Are we eliminating the economies of mass production by the application of unsound policies in mass-selling, or are we considering our obligations to our investors, our employees, our dealers, our customers, and the public, and by continuous intelligent and economical means developing procedures and practices which will coordinate all of our sales activities into an intelligent, unified program to make every dollar of sales expense produce the maximum profitable return on the money, labor and effort involved?

Those companies which have catechized themselves with these and other questions, to identify the sources of the trouble, and have ceaselessly worked to eliminate them, have laid the foundation for producing good profits, good wages, and good-will, but above all have proven to the Monopoly Investigating Committee that they have fulfilled Mr. Berle's specification of "designing an organization that actually works." In thus handling their own problems voluntarily, they are saved the possible embarrassment of later having to correct their inequities, under some form of governmental supervision or regulation.

In many of these discussions which are taking place today, among the economists and the governmental representatives who have the authority to effect such remedial reforms, there arises continually the topic of regulation by the government to do those things which the oil companies themselves are unable or unwilling to do. Even Mr. Berle, in his memorandum, refers to the benefits to the companies and to the consumers, if some form of planning, under governmental supervision, were undertaken to overcome the difficulties which now exist. We cannot close our eyes or our ears to these theories of today which may become the facts of tomorrow.

All of us will agree that concerted action among the oil companies to clean up any existing embarrassing situations would be most helpful. But, as noted earlier in this article, we are faced with the inevitable fact that concerted action among oil companies, at the present time, on any topic whatsoever is dreaded and shunned by the companies, for they are conscious of the fact that evidences of it are continually searched for by some governmental authorities. Further, in spite of allegations to the contrary, the history of the oil industry shows that completely concerted action among the oil companies is too difficult to obtain, for there will be always some companies who, for one reason or another, will choose to refrain from participating in any joint action, and will pursue individual courses.

A. A. Berle, Jr., assistant U. S. secretary of state, leaving the White House.

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It seems, therefore, that this is not the propitious time for the oil companies to say, "Who will be the first to start to correct these conditions which we all deplore? Our company would like to do it, but if we do, we will suffer unless the X Company and the Y Company and the Z Company do it."

Before such decisions to postpone action are really finalized, it might be wise to consider the consequences of postponement. Such questions should be asked: "Indications are that ultimately we may have to change these policies, so why not do it now?" and "How much money are our stockholders, employees, and our customers losing by our continued failure to correct bad situations?"

If these questions are conscientiously asked, and as conscientiously answered, there might be no further consideration of a desire to await either the millennium of concerted action by all oil companies or the punitive effect of mandatory governmental regulations, before these necessary reforms would be effected.

Already, some companies have taken the lead and have started to adopt those policies which will contribute most to the profitability of their operations. Principal parts of the programs which these profit-minded companies have put into effect are:

A. The coordination of all of their sales elements—merchandising, advertising, publicity, public relations, market research, sales promotion, and personnel training—so that all of them focus with maximum effectiveness at the point-of-sale, to produce through their united action, many times more sales and profits than they could produce separately—and at greatly reduced expenses.

Such team-work is vastly more profitable than a series of individual uncoordinated efforts. All of these sales activities ultimately focus at the point-of-sale; the companies which operate these sales functions as uncoordinated efforts, force their dealers to tax their own ingenuity to do the coordinating work for the company. Successful companies have found that it is vastly more beneficial and profitable to coordinate such activities themselves, before their use by their dealers.

Other operations of the company—production, transportation, and refining—have been well coordinated, but less frequently has the same thinking been applied to the sale facilities—human beings, advertising, and sales promotion. Such coordination forces all dollars of expense for sales and advertising to team together to produce the maximum profitable return at minimum expense.

B. Reducing operating expenses as much as possible below 80 percent of the sales income. In 1937, every one percent reduction in cost of goods and selling, general, and administrative expenses, for major oil companies, increased their net profits by over 10 percent; preliminary data for 1938

indicate that, for most companies, a one percent reduction in these expenses would have increased the net profits of the companies by almost 20 percent. A reduction of three percent for example, in these expenses, would have increased many companies' net profits, in 1938, as judged by preliminary data, by almost 50 percent—and no department head would state that he could not save three cents out of each dollar he is now spending.

C. Stopping the feverish activities to get new dealers, and instead helping to build up the dealers the companies now have. It is agreed that there are three ways to get more gallonage—taking dealers away from competitors, promoting new outlets, or building up the present dealers.

Good dealers are frozen to competitors; the promotion of new outlets is expensive and difficult; the most profitable method of increasing gallonage is to develop the present dealers to make profits for themselves and for the company.

Building up the present good dealers into better dealers proceeds simultaneously with the elimination of poor dealers, in the surrounding neighborhood, who cannot become worth-while representatives of the company. A certain amount of their business will naturally flow to the good dealer, giving the company one good dealer making profit, rather than three, for instance, who divide a fixed amount of business, and who are all unprofitable. The application of this principle of selective selling is being successfully used by these companies, because they wisely recognize that, in spite of all their efforts, only a certain percentage of the motorists will buy one company's products, and it is unwise to divide that business among several outlets, no one of which has sufficient volume of business to become profitable.

D. Spending more time on developing sound, constructive merchandising plans, and less time on evolving devious trick leases, or new forms of concessions for cut-price arrangements with dealers. These companies have realized that constructive work by the company will help the dealers to sell the company's products to the public; the other kind of activities spends the company's money to buy the dealer's business, but does not help him to resell the company's products to the public.

These successful companies have recognized that profits can be materially increased by eliminating price-cutting in any form—as extra concessions to dealers, longer rentals and secret extra margins, payment for advertising privileges, or lowered tank-wagon prices; they know that a price-cut of one cent per gallon, on every 100,000,000 gallons of gasoline sold, slashes gross income and net profits of the company by $1,000,000.

E. Using all possible means to sell the products at a reasonable price, and not being stampeded by some competition, which believes that the only way to sell merchandise is to cut its price. The successful marketers know that it costs just as much to produce and distribute a gallon of gasoline that sells for 15 cents, as one that sells for 10 cents—and the 15-cent price can show a profit, while the 10-cent price may show a loss. It is just a gallon of gasoline until it reaches the point-of-sale where the consumer exchanges his cash for it; the amount of cash paid by the consumer determines the profitability of the entire process of transportation from well to automobile.

F. Eliminating the emphasis on gallonage and increasing the emphasis on profits. The successful companies ask a dealer "How are your profits?" and not "How is your gallonage?" They know that profits, and not gallonage, are what keep the dealers and the companies in business. These companies recognize that the nerve-racking race for gallonage, among the oil companies, has been one of the contributing factors to the continued unprofitable operations of the marketing departments of many companies. Only by supreme effort have the successful marketing companies been able to change, within their own companies, those policies which continuously produce losses, and result from the mad scramble for gallonage which has so beset the petroleum industry.

G. Building up the human relationships between the company and the dealer, and between the dealer and the company's customers, so that goodwill and patronage will help to produce profits for the company. The wise companies have recognized that profits definitely accrue from humanizing their contacts with their own personnel, their distributors, and their dealers; they have done everything possible to train, stimulate and supervise these distributors and dealers, so that their contacts with the public will produce the maximum profit for the distributors, the dealers, and the company.

SUMMARY

The oil industry is facing today some of the most serious problems of its existence. Although the history of the industry is studded with brilliant triumphs over physical difficulties, today, its problems are of a different kind. But no one can deny that the industry has proven unmistakably that it has a wealth of executive ability to solve the most difficult problems of any nature.

Within the past year, the industry has been burdened with investigations and criminal trials, has been threatened with regulatory legislation, has been loaded with increased tremendous taxes, has been beset by internal strife and dissension, and yet it still must continue to render adequate service to its customers.

Few would be so bold as to hazard a guess what another twelve months will hold, but the indications are quite definite, as judged by activities in other industries, that the oil companies should wisely consider a program of beginning to correct, on their own initiative, those activities which, upon mature analysis, prove to be unsound, uneconomic, and unprofitable. If the oil companies, of their own volition, inaugurate a plan of correcting and eliminating unprofitable marketing practices, such action should go a long way, as experience has proven in other industries, to reduce the strength of the desire on the part of investors, legislators and the general public to accomplish not only these reforms, but many others, over the opposition of the oil companies.

Lessons can well be learned from other industries, so that the oil companies, who have suffered long and hard at the hands of various governmental authorities, may be spared the punishing effects of that legislative trend which is manifesting itself frequently and in various forms. If the oil companies will ride with this irresistible force of public opinion, and not fight it, their voluntary cooperation in anticipating these reforms can do much to help to direct this force into channels that will increase the comfort, the permanence, and the profitability of the existence of the oil companies.

The record of accomplishments of the oil industry shows that the industry needs no defense from anyone to prove its ability to get things done. The record of the industry's technical, scientific, and administrative accomplishments in other fields testifies that there is a wealth of executive ability within the industry to evolve constructive, intelligent sales practices, which will head off opposition from the public and the government, and will avoid further conflicts with governmental regulations.

If the industry's experienced executive ability concentrates on the problems of marketing, as it has done on production, transportation, and refining, the industry will present a brighter and improved picture, for no longer will the profits from production and transportation need to be utilized, to the detriment of the investors, the employees, the customers and the public, to absorb the losses in the refining and marketing divisions, for these branches, too, with their problems brought from the darkness into the light, and exposed and corrected, will begin to produce increased profits for the industry.

CHANGING SOURCES of British Oil Imports

By Alec H. Day

ANALYSIS of British oil import statistics for 1938 shows important changes in sources of supply, and wide variations in the volume of shipments of individual products. Total imports of petroleum for the year established a new record of 91,658,000 bbl., exceeding the previous year's record by 3,808,000 bbl., or 4.3 percent.

The rise in aggregate shipments was due almost entirely to big increases in arrivals of crude oil and motor spirit. Receipts of most other important finished products were below the 1937 figures.

British industry was declining slightly during the greater part of last year. The increase in total oil imports may thus be said to support the assumption that modern developments bring continually increasing demands for petroleum. Larger import figures for 1938 are also attributable to additions to the country's stocks, which were still increasing substantially in the earlier months of the year.

Customs releases of finished oil products for home consumption for the first 11 months expanded by only 1.3 percent over the same period of 1937. Imports of all finished products advanced by 3.6 percent on the full year. It is therefore a fair deduction that oil was still going into storage in Britain during 1938.

Continued expansion in imports of motor spirit, which rose by 8.3 percent, reflects the rise in the number of motor vehicles in use in Britain. The total of private cars alone was increased by approximately 200,000 during the year, and a reliable estimate puts the rise in actual consumption of motor spirit at 4 percent against 1937.

Two main reasons may be put forward for the decline of 9.8 percent in the volume of lubricating oil imports. The first and obvious explanation is that more lubes are being manufactured in the country from imported crude. Another reason suggested is that modern motors and other machinery consume lubricants more economically than earlier types. Little, if any, of the year's reduction in lube imports is attributed by oil men to falling off in the activity of industrial machinery.

Gas oil arrivals for the year showed a large increase of 13.2 percent on 1937, and the value increased by 15.8 percent. This suggests that a larger volume of oil suitable for road Diesel engines has been coming into the country under the classification of gas oil instead of falling into the fuel oil category.

Lower imports of fuel oil may also be explained partly by the same factor, but reduced fuel oil bunkering at British ports is a more likely explanation. The reduction of 455,000 bbl. in fuel oil receipts is not far short of the decline shown by official figures of oil shipped as bunkers during the year.

A notable feature of the statistics is a further advance in the total of crude imported, the rise on the year being equal to 7.7 percent. Crude import figures have now established a trend completely contrary to the declining figures of a few years ago. Increased refining facilities in Britain, and the attention now being devoted to the production within the country of bituminous products, provide an explanation of higher receipts of crude petroleum.

Important changes during 1938 in the sources of Britain's oil supplies are largely the result of the fading out of Mexico from the oil picture. Arrivals from Mexico ceased altogether soon after the spring expropriation of foreign oil properties in the Republic, and total shipments for the year were only 1,552,000 bbl. against 4,111,000 bbl. in 1937.

British imports from Roumania were restricted by the falling off of production in that country, Roumania's system of artificially fixed export prices, and the general congestion of her exchange position.

Falling receipts from Mexico and Roumania were offset by striking increases in shipments from the United States and the British West Indies, which means principally Trinidad.

United States shipments of all oil products to the British market advanced by 5,211,000 bbl. to 16,064,000 bbl., or nearly 50 percent although crude shipments declined. The absence of Mexican supplies probably induced some major companies to ship more oil from America to Britain. Smaller independent distributors in the British market were also responsible for a considerable change over. As a result of adverse Roumanian conditions, they took more of their supplies from the Gulf.

BRITISH OIL IMPORTS BY SOURCES

	1938 Barrels	1937 Barrels
Netherlands West Indies	30,752,000	32,403,000
Iran	17,911,000	17,043,000
U.S.A.	16,064,000	10,853,000
British West Indies	5,945,000	3,757,000
Iraq	4,058,000	3,345,000
Venezuela	3,954,000	2,379,000
Roumania	2,665,000	4,057,000
Mexico	1,552,000	4,111,000

Positions of the three largest suppliers remain unchanged on the year, but British West Indies has now attained fourth place at the expense of Mexico.

Prices of most petroleum products were heavily reduced during 1938, as the accompanying table shows. While total imports increase in volume by 4.3 percent over 1937, the value was reduced by 3.7 percent. This reduction in the average value of imports conforms to the trend of British selling prices, which are still being kept on a highly competitive price level as a discouragement to the entry of new distributing interests into the market.

BRITISH OIL IMPORTS BY PRODUCTS

	Volume 1938 Barrels	Increase (+) or decrease (−) percent on 1937	Value 1938 £	Increase (+) or decrease (−) percent on 1937
Kerosene	5,857,000	− 6.1	2,983,240	−13.0
Motor spirit	41,786,000	+ 8.3	24,828,987	− 2.4
Lubricating oil	3,115,000	− 9.8	3,984,117	−12.8
Gas oil	4,518,000	+13.2	2,118,338	+15.8
Fuel Oil	19,596,000	− 2.3	6,554,375	− 9.5
Other sorts	560,000	+18.4	388,037	+ 7.1
Total products	75,432,000	+ 3.6	40,857,094	− 4.6
Crude	16,226,000	+ 7.7	5,179,155	+ 3.8
	91,658,000	+ 4.3	46,036,249	− 3.7

HAIFA REFINERY

Construction of the new Haifa plant of Consolidated Refineries Ltd., in Palestine, has been started. The picture below shows a posthole digger-equipped tractor at work on the site. Modern types of equipment, including crude reducing and re-forming units and plant for chemical treatment and washing, are to be laid in. A hundred tanks will be put up to store products during the manufacturing process before pumping to the Iraq Petroleum Company tanks at Haifa docks for shipment.

Photo from Caterpillar Tractor Co.

U. S. Assumes Greater Importance as Exporter

Larger Purchase of Crude by France, Japan and Italy — Major Advances in Gasoline Shipments—China Incident Reduces Kerosene Sales—Continued Increase in Fuel Oil Demand—Drop in Bunkering Breaks Progressive Recovery From 1934 Low.

A FAVORABLE balance in export and import trade of the United States in crude petroleum during 1938 is indicated by figures compiled by the Fuels Section, Department of Commerce. Total exports of crude oil during 1938 amounted to 77,272,000 bbl., compared with 67,127,000 bbl. exported in 1937. This increase was primarily due to larger purchases by France, Japan, Italy, and Sweden. France purchased 6,677,000 bbl. more crude from the U.S.A. in 1938 than in 1937, while Japan, Italy, and Sweden increased their purchases by 5,295,000, 2,207,000, and 280,000 bbl., respectively.

Canada, principal crude oil customer, imported 3,235,000 bbl. less of American crude than in the preceding year, presumably due to the all-time record production of crude in Canada. The United Kingdom failed by 600,000 bbl. to equal its 1937 record and British import statistics indicate that the U.K. is increasing its purchases of crude from Netherland West Indies, Iraq, and Venezuela, while taking less oil from Peru, Mexico, and the United States.

U.S. import statistics for 1938 show that 22,451,000 bbl. of crude paying a duty of $0.21 per bbl. were imported for immediate consumption as against 25,395,000 bbl. in 1937. Of the 1938 total, 20,850,000 bbl. or 92.9 percent were imported from Venezuela, while Mexico with 1,600,000 bbl. and Canada with 1,000 bbl., accounted for the remainder. In 1937, Venezuala with 21,272,000 bbl. and Mexico with 3,512,000 bbl. accounted for 97.6 percent of American crude oil imports, the remainder being supplied by Colombia and Trinidad with 431,000 and 181,000 bbl., respectively.

Imports of crude imported in bond for manufacture and export during 1938 showed a gain of 1,684,000 bbl. over 1937, or a total of 3,599,000 bbl. In the preceding year, the entire quantity came from Venezuela while in 1938 Mexico supplied 882,000 bbl.

A general improvement in American gasoline exports is noted. Exports of gasoline and other petroleum motor fuel, combined with naphtha, solvents, and other finished light products increased 30 percent over the record of 1937, mounting from 32,044,000 bbl. to 41,590,000 bbl. Imports of gasoline during 1938 and 1937 were only about 4,000 bbl. in each year.

U. S. OIL EXPORTS IN 1938*

COUNTRY OF CONSIGNMENT	CRUDE OIL		GASOLINE, NAPHTHA, ETC.		NATURAL GASOLINE		MINERAL SPIRITS		KEROSENE		GAS AND LIGHT FUEL OIL		RESIDUAL FUEL OIL		LUBRICATING OIL		LUBRICATING GREASE	
	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent	Pounds	Percent
Argentina	1,504,255	2.0	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	643,506	0.8
Australia	.....	....	2,001,000	4.8	.....	....	47,598	42.9	169,000	2.3	.....	....	.....	....	415,000	4.5	5,643,375	7.3
Belgium	349,090	0.4	1,288,000	3.1	23,378	0.4	.....	....	51,000	0.7	1,126,093	4.0	.....	....	799,000	8.6	4,647,850	6.0
Brazil	.....	....	1,460,000	3.6	.....	....	15,526	13.9	401,000	5.5	433,501	1.5	.....	....	243,000	2.6	1,916,046	2.5
British India	.....	....	.....	....	.....	....	.....	....	.....	....	50,746	0.2	.....	....	309,000	3.3	1,593,995	2.1
British Malaya	.....	....	.....	....	204,401	3.3	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
British Oceania	.....	....	.....	....	.....	....	.....	....	.....	....	32,518	0.1	.....	....	.....	....	.....	....
Canada	24,845,141	32.2	2,473,000	5.9	799,702	13.1	1,588	1.4	229,000	3.1	562,906	2.0	964,743	6.2	486,000	5.3	5,284,001	6.8
Canary Islands	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	43,000	0.5	1,943,573	2.5
Chile	.....	....	.....	....	.....	....	1,746	1.6	.....	....	249,175	0.9	2,296,578	14.8	.....	....	2,141,892	2.8
China	166,120	0.2	.....	....	.....	....	.....	....	46,000	0.6	369,271	1.3	.....	....	67,000	0.7	834,590	1.1
Colombia	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	859,463	1.1
Cuba	904,988	1.1	776,000	1.9	.....	....	.....	....	.....	....	117,349	0.4	1,356,034	8.7	37,000	0.4	1,676,788	2.2
Czechoslovakia	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	36,000	0.4	.....	....
Denmark	.....	....	660,000	1.6	.....	....	.....	....	496,000	6.8	598,669	2.1	116,683	0.7	205,000	2.2	.....	....
Egypt	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	76,000	0.8	.....	....
Finland	.....	....	.....	....	.....	....	.....	....	67,000	0.9	37,075	0.1	.....	....	.....	....	.....	....
France	16,742,506	21.6	2,924,000	7.0	856,614	14.0	4,078	3.6	.....	....	86,922	0.3	153,232	1.0	529,000	5.7	4,307,263	5.6
French Africa	.....	....	.....	....	.....	....	.....	....	51,000	0.7	.....	....	134,267	0.9	.....	....	.....	....
French Indo-China	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	516,558	0.7
Germany	1,223,099	1.6	.....	....	52,047	0.9	.....	....	.....	....	3,889,213	13.7	.....	....	1,215,000	13.0	1,874,951	2.4
Greece	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	36,000	0.4	.....	....
Guatemala	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	228,984	1.5	.....	....	.....	....
Honduras	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	67,500	0.4	.....	....	.....	....
Hong Kong	.....	....	.....	....	.....	....	.....	....	160,000	2.2	215,747	0.8	58,938	0.3	41,000	0.5	1,752,361	2.3
Ireland	.....	....	.....	....	12,354	0.2	.....	....	.....	....	.....	....	222,419	1.4	.....	....	.....	....
Italy	6,750,522	8.7	419,000	1.0	.....	....	.....	....	.....	....	.....	....	1,200,704	7.8	306,000	3.3	1,307,273	1.7
Japan	21,289,572	27.6	1,063,000	2.6	384,278	6.3	.....	....	.....	....	5,297,464	18.7	3,029,586	19.5	289,000	3.1	4,735,607	6.1
Kwantung	916,863	1.2	637,000	1.5	.....	....	.....	....	162,000	2.2	.....	....	.....	....	57,000	0.6	3,701,133	4.8
Latvia	.....	....	.....	....	.....	....	.....	....	68,000	0.9	.....	....	.....	....	.....	....	.....	....
Mexico	.....	....	.....	....	.....	....	.....	....	.....	....	373,380	1.3	894,505	5.7	87,000	0.9	1,446,833	1.9
Morocco	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	184,120	1.2	.....	....	.....	....
Mozambique	.....	....	.....	....	.....	....	4,312	3.8	.....	....	.....	....	.....	....	59,000	0.6	1,666,018	2.3
Netherlands	326,130	0.4	2,122,000	5.1	294,501	4.8	.....	....	699,000	9.6	2,334,000	8.3	802,233	5.2	211,000	2.3	2,559,932	3.3
Netherland (East) India	.....	....	.....	....	.....	....	.....	....	.....	....	181,250	0.6	.....	....	56,000	0.6	1,477,679	2.0
Netherland West Indies	.....	....	3,052,000	7.3	1,799,634	29.4	.....	....	1,209,000	16.6	5,110,747	18.1	.....	....	.....	....	.....	....
New Zealand	.....	....	873,000	2.1	.....	....	6,929	6.2	69,000	0.9	104,686	0.3	91,104	0.6	69,000	0.8	1,130,378	1.5
Norway	.....	....	.....	....	.....	....	.....	....	104,000	1.4	391,878	1.4	.....	....	.....	....	512,232	0.7
Panama Canal Zone	.....	....	.....	....	.....	....	.....	....	.....	....	928,783	3.3	853,556	5.5	.....	....	.....	....
Peru	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	106,460	0.7	.....	....	.....	....
Philippines	.....	....	915,000	2.2	.....	....	.....	....	478,000	6.6	505,564	1.8	678,467	4.4	77,000	0.8	3,052,711	3.9
Poland and Danzig	.....	....	.....	....	.....	....	.....	....	.....	....	48,205	0.2	.....	....	.....	....	.....	....
Portugal	.....	....	.....	....	.....	....	.....	....	115,000	1.6	.....	....	95,208	0.6	38,000	0.4	.....	....
Portuguese Africa	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	70,211	0.5	.....	....	.....	....
Spain	.....	....	2,052,000	4.9	43,300	0.7	.....	....	.....	....	306,024	1.1	425,172	2.7	106,000	1.1	575,448	0.7
Spanish Africa	.....	....	.....	....	.....	....	.....	....	.....	....	206,219	0.7	428,121	2.8	.....	....	.....	....
Sweden	930,295	1.2	2,390,000	5.8	.....	....	.....	....	421,000	5.8	481,368	1.7	426,401	2.7	159,000	1.7	1,277,158	1.6
Switzerland	280,455	0.4	.....	....	.....	....	.....	....	.....	....	169,961	0.6	.....	....	.....	....	.....	....
Turkey	.....	....	.....	....	.....	....	.....	....	200,000	2.8	51,339	0.2	.....	....	.....	....	.....	....
Union of South Africa	217,017	0.3	619,000	1.5	.....	....	23,698	21.5	.....	....	77,989	0.3	.....	....	117,000	1.3	2,392,268	3.1
U.S.S.R.	.....	....	1,120,000	2.7	426,147	7.0	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
United Kingdom	153,028	0.2	8,736,000	21.0	1,215,791	19.9	.....	....	1,554,000	21.4	3,611,778	12.8	496,653	3.2	2,459,000	26.2	6,359,684	8.2
Venezuela	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	35,000	0.4	785,806	1.0
Other Countries	672,688	0.9	3,757,000	9.0	1,529	....	5,693	5.1	520,000	7.3	332,440	1.2	154,405	1.0	650,000	7.0	10,699,660	13.1
Totals	77,271,699	100.0	41,590,000	100.0	6,113,676	100.0	111,168	100.0	7,262,000	100.0	28,295,745	100.0	15,536,286	100.0	9,312,000	100.0	77,286,039	100.0

* Table based on statistics compiled by Fuels Section, Metals and Minerals Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Of the gasoline exported by the U. S., U. K., which took 15 percent in 1937, accounted for 21 percent in 1938. As in 1937, Netherland West Indies stood second with 7.3 percent. France, Canada, and Sweden in the order named, superseded the Netherlands, Belgium, aand Australia for third, fourth, and fifth places. Two interesting instances of augmented shipments are noted in Canada and Sweden, which took increases of 1,603,000 and 1,564,000 bbl., respectively. Spain purchased 1,229,000 bbl. more in 1938 while Union of South Africa fell from 9th to 19th place as a buyer of gasolines, failing by 530,000 bbl. to equal its 1937 purchases.

Export trade in natural gasoline during 1938 totalled 6,114,000 bbl. as against 3,738,000 bbl. in 1937, an increase of 63.6 percent. Netherland West Indies continued to head the list of customers in 1938, taking almost 30 percent. The U. K., with 20 percent, displaced Canada for second place. France also advanced, ranking third in 1938 with 14 percent while Canada fell back to fourth place with 13 percent. U.S.S.R. appeared in fifth place, purchasing 426,000 bbl. of American natural gasoline. The Soviets were entirely absent from the 1937 list of customer nations. The Netherlands also attracts attention, receiving 295,000 bbl. compared with only 14,000 bbl. in 1937.

Although not showing as great a percentage increase as the other gasolines, American export trade in mineral spirits advanced from 97,303 bbl. to 111,168 bbl., or 14.2 percent, in 1938. Australia, Union of South Africa, and Brazil continued to hold their positions as chief purchasers.

A recession of 19.3 percent from the 1937 figure is noted in U.S. exports of kerosene for 1938. The decrease amounted to 1,402,000 bbl., 7,262,000 bbl. being shipped abroad last year as against 8,664,000 bbl. in 1937. Disturbed conditions in the Orient, where the losses totalled 1,245,000 bbl., evidently are the chief causes of lower kerosene export sales. The Netherlands decreased its purchases by 395,000 bbl. while Denmark and the U. K. made the greatest gains, by 440,000 bbl. and 260,000 bbl., respectively. In contrast with the volume exported, only 12 bbl. of kerosene were imported in 1937 while none appeared on the import records for 1938.

U.S. export sales of all fuel oils have increased progressively from 1932, when such sales were recorded as 17,831,456 bbl., to 1938 when the trade totaled 43,832,031 bbl. Export classification for fuel oils consists of two groups gas oil and distillate fuel oil (including Diesel, furnace, and other overhead fuel oils), and residual fuel oil. Since 1932, when statistics were first segregated, export shipments of distillates have increased from 45.5 to 64.5 percent of the total in 1938. Exports of residuals have decreased proportionately.

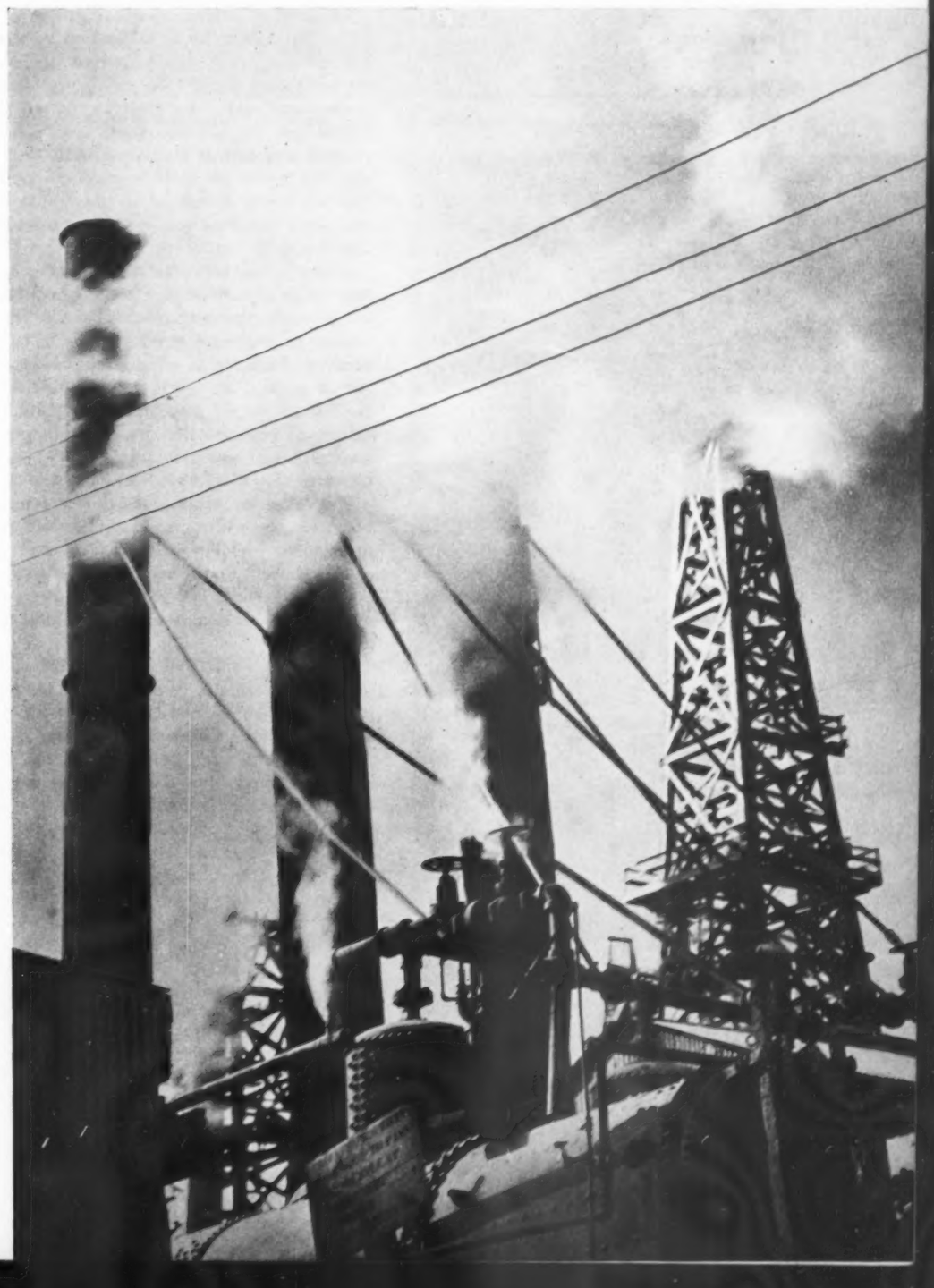
Bunker Oil Laden on Vessels in Overseas Trade (Barrels)

Customs District	1937	1938
New York	17,579,000	17,123,000
Los Angeles	5,105,000	3,778,000
New Orleans	2,620,000	2,600,000
Maryland	2,197,000	2,159,000
Galveston	2,018,000	2,880,000
Philadelphia	1,242,000	1,152,000
Sabine	1,054,000	778,000
Hawaii	745,000	467,000
Puerto Rico	476,000	451,000
Virgin Islands	416,000	416,000
All others	4,136,000	3,986,000
Total	37,688,000	36,059,000
American vessels	17,234,000	14,217,000
Other vessels	20,454,000	21,842,000

A slight decline, 2.5 percent, was noticed in export sales of gas oil and distillate fuel oil—29,011,228 bbl.. in 1937 against 28,295,745 bbl. in 1938. In contrast to the slight decrease in overseas trade in light fuel oils, sales of heavy fuel oils increased from 12,810,012 to 15,536,286 bbl., or 21.3 percent.

Bunker oil loadings in 1938 on vessels engaged in the overseas trade of the United States showed a decrease of 1,629,000 bbl. from the preceding year to 36,059,000 bbl. This represents a four percent decline and is a break in the progressive recovery since 1934. The customs districts of New York and Los Angeles retained their ranks in first and second places, respectively, while Galveston forged ahead of New Orleans for third place advancing from fifth position in 1937. The heaviest decrease occurred in Los Angeles—where 1,327,000 bbl. less were sold in 1938 than in 1937, or 81.5 percent of the total loss.

Steam used for drilling and deepening wells in the Signal Hill oilfield, California.
Snider-Triangle



Time and Cost Reduced by PIPELINE ANTICIPATOR

Electrical Device Developed Which Locates Pipelines Automatically While Excavating—Warns Operator of Approach to Unmapped Cables and Other Obstructions.

The anticipator is as compact as and appears like a small radio—ruggedly constructed, it is weather proof, easily installed and simple to operate.

ENGINEERS in the oil and gas industry have developed many ingenious methods and practical equipment for solving their pipeline problems and expediting their construction work. Certain difficulties solved in construction of municipal duct lines are also involved in pipeline construction and repair work, and this article serves to introduce to the petroleum industry methods which will further simplify and expedite work on oil and gas lines for gathering, cross-country, distribution, and refinery yard pipelines.

In either trenching for a new pipeline or excavating to repair an existing one, an important factor for consideration is the existence of other pipelines, water mains, electric cables, and the like—necessitating a preliminary survey for their location. Recourse can be had to maps, blue print records, and surface indications, but these will not cover all such obstructions and there is much danger of damaging these properties and thus leading both to trouble and expense.

Extensive investigations and field tests were made of various pipe locators in order to determine the most practical method of tracing underground pipes and cables, but none was found to be suitable for attaching to an excavating machine nor practical enough to permit mechanized excavation safely and economically in a maze of pipes such as is encountered in urban streets—the ultimate test of the practicality of such a device. Radio, induction, earth resistivity, magnetic, acoustical and submarine locator methods have been tried on streets of New Jersey, but all require one or more experienced engineers to make a survey several days in advance of the construction forces.

A few of these methods are quite practical for survey work and can be used to locate pipes within a foot after 15 to 45 min. survey for each individual pipe.

The induction principle, using a direct connected interruptor sending set, remote exploring coil and amplifier set, requires connections to two carefully selected parts of the pipe system and the return wire interferes by predominating as it carries more current than any one of the many parallel pipelines. The same principle, but using a remote oscillator, transmitter and receiver, gets interference by automobiles and other traffic, while it is impaired in a maze of pipes. It requires the services of especially trained men.

Use of the automatic pipeline anticipator enabled the operator to stop his ditcher when it got within three inches of the gas pipe.

Earth resistivity measurements between a metal stake and buried service pipes are not practicable for paved street work. The position of a supersensitive vertical compass with respect to the earth's magnetic poles must be reckoned with at all times, should that method be employed. A supersensitive compass neutralized for the earth's field is also affected by proximity of automobiles, power cables, rails, or a maze of pipes; it requires adjusting for leveling, earth's magnetism, and so forth.

Where blue print records, valve box covers, and manholes exist they will act as a guide, but they are not dependable and generally represent only a low percentage of the total pipes and cables to be encountered.

For mechanical excavating, the automatic pipe anticipator surpasses the other pipe locators in many ways—such as being attached to the digging machinery; absolute immunity to any electrical interference; time saving; not requiring advance survey work.

Ditching machine operators automatic-

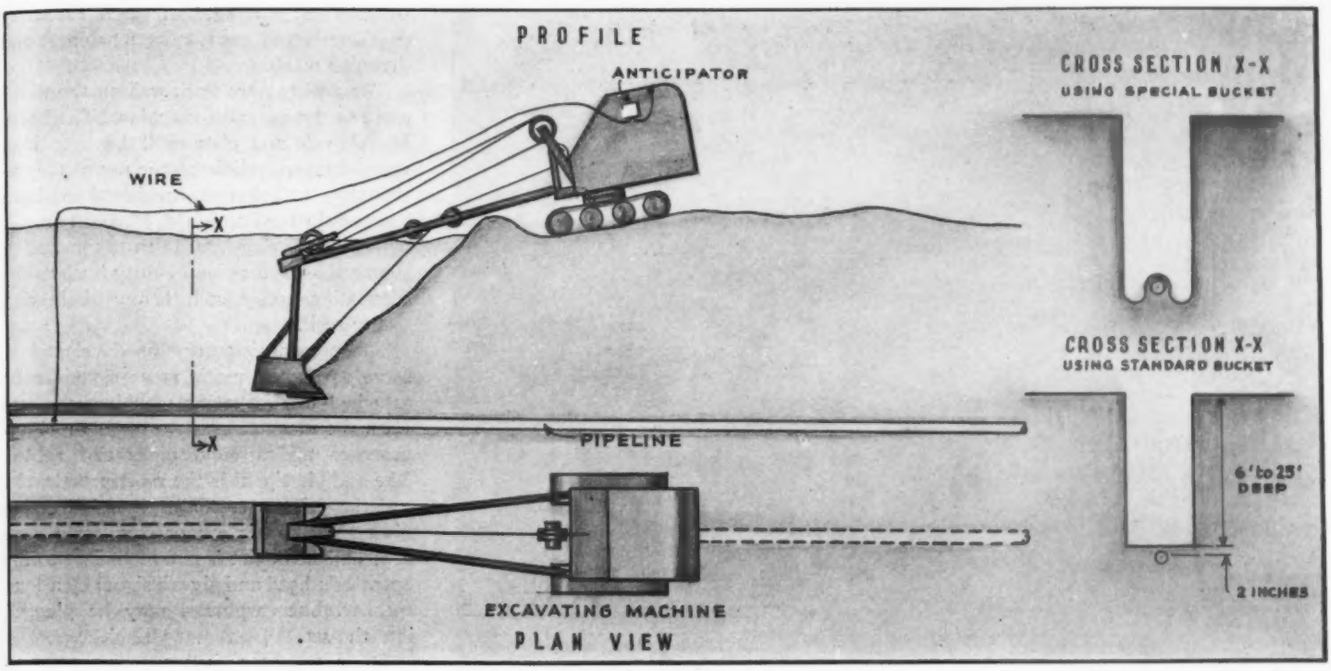


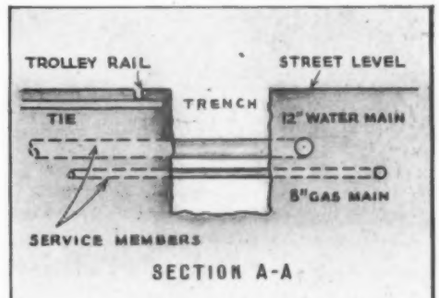
Diagram showing how a cross-country pipeline may be automatically located and uncovered for repairs by use of the anticipator.

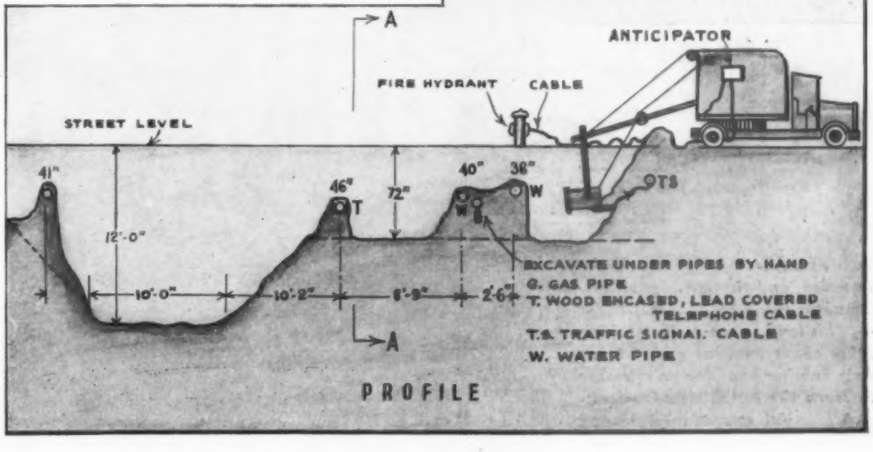
ally locate pipelines, cables and cross-pipes. The excavator operator does not lose time or damage pipes by depending upon blue prints, etc., now he has his own automatic pipe anticipator mounted within 18 in. of his head. It distinguishes whether his bucket teeth are touching an unknown pipe, or whether they are one or more inches, a few feet, or many feet away from a pipe. The operator has full control of the above distinguishing feature, which can be applied to the pipeline which is being uncovered for repairs. Therefore, he excavates rapidly, completely, and without hesitation, regardless of pipe sizes or materials.

The 315,000 mi. of cross-country petroleum and gas pipelines between American cities, as well as those in the oilfields themselves, require constant repairs while new lines are added regularly. These can be automatically located and completely unearthed by an excavator equipped with an anticipator and a specially shaped bucket to straddle the pipeline. This can be done by simply digging parallel to, above, and on each side of the pipe while the operator excavates for constant maximum signal and never loses the line.

The Public Service Electric and Gas Company, of New Jersey, has successfully used anticipators to safe-guard several thousand lost cross-pipe, and parallel mains while excavating in municipal streets to construct electrical duct line systems. This utility company resorted to mechanized underground construction in congested streets, infested with live cables and pipes, under conditions where it was formerly deemed necessary to dig cautiously with picks, hand shovels, pneumatic tools and small-charge blasting in order to save time, economize, decrease accidents, and create good-will with affected business establishments. It is imperative that construction proceed without damaging existing pipes and cables.

Public Service Electric and Gas Company has successfully used the anticipator on crawler, semi-crawler and wheel-mounted excavators; lever and air-controlled machines; 180, 270, and 360 deg. revolving cranes; back-hoe, clam-shell and skimmer buckets. Contractors have used the anticipators on ladder-type and wheel-type ditching machines. It can also be used on





Example of typical work done by anticipator-equipped back-hoe under urban conditions for excavating manhole and trench.

other types: pushing, boring,and tunneling machines; road excavating machines; and dredging machines.

The anticipators work well on the wheel and crawler-mounted machines. The backhoe shovels and clam-shell buckets lend themselves splendidly to the use of the anticipator attachment, which has been successfully used on 3/8, 1/2, 3/4, and 1 cu. yd. machines, ranging from 11 to 18 tons, using standard as well as heavy-duty buckets for excavating rocky soil, heavy shale and seamy rock.

The pipe anticipator was developed to serve as an automatic radio signal to be attached to excavating machines to forewarn the machine operator as his tool approaches underground pipes and cables. The audible signal is the most practicable, assisting the operator without diverting his eyes from his job or interfering with control. The device is mounted close to the operator's head and gives a signal by a loud speaker, but earphones may be plugged into the set.

The anticipator gives a constant supervisory signal to indicate it is in a workable condition, and the operator adjusts his soil dial for obtaining a positive distinguishing signal when the bucket teeth are six to twelve inches from a pipe and digs until the teeth come within two to four inches of the pipe. The signal increases in intensity of sound as the tool approaches the pipe and decreases as it moves away. A unique feature is that it is immune to all electrical interference. The set is ruggedly constructed for severe service, easily installed, and maintenance is negligible. The control circuit includes the excavator bucket, the service pipe and the earth between the teeth and a service pipe. As the bucket moves into the earth toward a pipe, the impedence of the separating earth decreases and the volume of the signal increases.

Two examples of the anticipator installed and in use. Above—Operator using earphones. Right—With loud speaker. Installation takes about an hour and it takes only another hour for an operator to learn the essentials of successful operation.

The anticipator has test, soil, and volume control dials: the test dial is used to simulate exactly the action of the digging tool; the soil dial is adjusted where the character of the earth differs, and requires a more distant setting with rapid digging whereas relatively slow excavation permits a close setting; the volume control is set according to the operator's degree of hearing.

The machine can dig, bore, push or pull rapidly while the operator is getting only a supervisory signal and excavate slowly and more cautiously as he receives a warning of approaching a service member. Due to the anticipator the machine can dig nearly all of the earth off the pipes and leave a small portion for hand excavation.

Trenches and manholes have been excavated when 12 in. away from parallel water and gas mains. Pipes of ½ to 24 in. sizes varying in spacing from a foot to 100 ft. apart but averaging 18 ft. separation have been excavated where the anticipators have been used.

The materials of these were copper, brass, lead, iron and steel (whether rusty, tarred or painted); also lead-covered and wood-encased cables.

During the developement and recording period 32,000 running feet of trench and manholes have been dug with the aid of the anticipators: 100 percent of the pipes and cables were undamaged for 20 percent of the projects, due to use of the anticipator, (90 to 97 percent were undamaged for the balance of the projects) even while training crane operators. Considerably less damage occurred to service pipes by mechanized excavation with the anticipator than occurred with pick and shovel excavation on directly comparable jobs. The slightest injury is listed as damage—a dent in a lead sheath of a cable, a break in its wood encasement, or a slight bend in a pipe. Many instances of damage were done by picks while trimming around the pipes.

The anticipator permits the buckets to work much closer to the pipes and cables than would otherwise have been practicable, and 93 to 96 percent of the total excavated volume was done by machine.

The anticipator has been used with nearly every type of mechanical shovel with standard and heavy duty buckets for excavating rocky soil, heavy shale and seamy rock. The anticipator has functioned equally as well on pneumatic spades, used for trimming manhole walls where obstructions interfered with the buckets getting to all sides.

Rain, sleet or snow and partially frozen ground have been no obstacle to the anticipator-equipped excavators. Contractors have used the devices successfully in trenches 80 percent filled with water.

Cluster of pipes are common in street work and an anticipator equipped machine excavated within two or three inches of these pipes—the earth underneath was removed by hand.

This picture illustrates strikingly how the anticipator functions equally well in the presence of high tension wires.

Modern Technique of HEAT CONSERVATION

John S. Wallis*

HEAT TRANSFER and the retarding of heat transfer is as old as the universe. These physical phenomena account for varying temperatures on different heavenly bodies and are responsible for the temperatures of our own planet and its seasonal changes. Man's first effort to control rates of heat transfer consisted of crude dwellings for protection against the elements and various types of clothing for bodily comfort according to local conditions. Although in the early days little was known of the physical laws of light and heat, it is interesting to realize that there was some classification between reflective and absorptive material. The utilization of insulation, of basic importance to all projects of mankind, is of great industrial importance and is an absolute necessity to the petroleum, chemical, and allied industries.

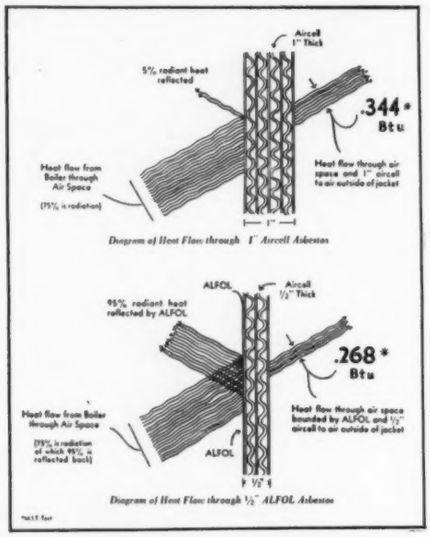

Aircell
1" Thick
5% radiant heat reflected
.344*
Btu
Heat flow from Boiler through Air Space
(75% is radiation)
Heat flow through air space and 1" aircell to air outside of jacket
1"
Diagram of Heat Flow through 1" Aircell Asbestos
ALFOL
Aircell
½" Thick
95% radiant heat reflected by ALFOL
.268*
Btu
Heat flow from Boiler through Air Space
(75% is radiation of which 95% is reflected back)
Heat flow through air space bounded by ALFOL and ½" aircell to air outside of jacket
ALFOL
½" ½"
Diagram of Heat Flow through ½" ALFOL Asbestos

Figure 1.

Research and experimentation over the past decade have not only produced many types of improved insulating material, but have also radically changed former conceptions of heat transfer. Until quite recently it was not fully realized to what extent all surfaces give off or emit radiation at different temperatures. It is now definitely known that surfaces at all temperatures below 900 deg. may give off large quantities of heat and heat transfer will take place across an enclosed space in absolute darkness. The quantity or rate of radiation and the wave length most strongly emitted depends upon the absolute temperature of the surface and the type of surface.

*Vice-President of Petro-Chem Development Company.

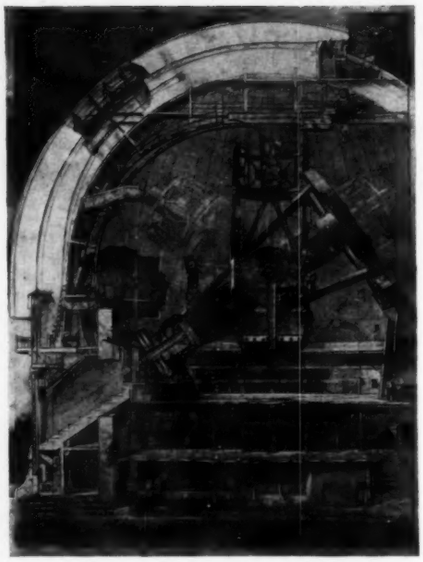


Figure 2—An example of a difficult insulating problem.

From surfaces of high emissivity at any given temperature, radiation will be given off consisting of a variation of wave lengths; for example, at 500 deg. F. heat radiation will be emitted with wave lengths of two to ten microns. The most strongly emitted wave length will range from four to seven microns and at this temperature all of the radiant waves are too long to affect the human eye and may be termed invisible heat.

Waves of this type in the infra-red range and at the red end of the solar spectrum pass through materials that reflect or absorb the shorter visible waves. A good example of how some materials are transparent to heat and red light waves is seen in the case of dust. Photographers often take pictures on special film by invisible heat radiation or infra-red rays, instead of by sunlight. They use this method to obtain pictures of distant objects through dusty atmosphere. The pictures come out clearly when pictures taken by light rays would be indistinct. The reason is that dust is relatively transparent to infra-red radiation.

As temperatures of surfaces are increased, the waves most strongly given off are shorter and shorter. At 11,000 deg. F., the sun gives off radiation of a wide range of wave lengths, from invisible ultra-violet to invisible infra-red—and including, of course, the colors in the visible spectrum, from violet to red. The wave most intensely emitted is of 0.42 microns, which is visible to the human eye as the color, green.

Most of the heat transferred by solar radiation is in the range of wave lengths to which the human retina is sensitive. It is visible radiation. Being a mixture of all colors, the effect of sunlight on the eye is no one color, but a combined effect which we call white.

This knowledge of the radiation and reflection of heat at lower temperatures has become of increasing commercial importance and new applications of this principle continually are being utilized.

Insulating material for the industrial field now covers a wide range of products including refractory clays, tile, asbestos, mineral wools, metallic foils, cork, and other substances which may be required for special services. A more thorough knowledge of laws governing heat transfer and the development of more efficient materials has led to the desirability, in certain instances, of utilizing combinations of insulating materials even at moderate or low temperature ranges. Figure 1 shows a comparison of insulating efficiency using 1 in. air cell asbestos as compared with ½ in. air cell asbestos in combination with aluminum foil. An analysis of this diagram shows that for approximately the same capital investment there is a reduction of approximately 50 percent in thickness and weight and an improvement of more than 20 percent in the insulating efficiency.

Greater theoretical knowledge of heat transfer and the selection of the most efficient types of material has logically led to improved technique in the mechanical applications. The Mt. Palomar Observatory as shown in Figure 2, is representative of modern research and is unique in its mechanical application. The mounting and frame must support the mirrors in precise relationship and even nominal temperature changes would result in loss of irreplaceable viewing time. The design is based on the maintaining of five degrees temperature variation in the dome and the variation of the temperature around the 200 in. reflector within one degree.

For installations of this type the insulation is built as an integral part of a permanent structure and will probably never be removed unless the entire structure becomes obsolete. By far, the greater num-

Figure 3—42 in. by 100 in. pre-fabric ated insulating panels before application.

ber of plants in the industrial field require that certain parts subjected to temperature, pressure, and corrosive conditions must be partially dismantled for inspection or repairs.

In the selection and application of insulation it has been general practice to balance first cost against calculated thermal efficiency and only minor consideration has been given to: simplicity of assembly; ease of removal and replacement; and protection against mechanical damage.

A simple analysis of plant maintenance figures will often show that lack of consideration of these factors is reflected in high maintenance cost and new insulation is required for replacements generally in direct proportion to the required frequency of inspection and repairs to the plant under consideration. As the salvage value of damaged insulation is a fraction of the cost of new material installed, the percentage maintenance cost may reach large proportions for certain types of equipment.

Recent installations have been made for industrial plants, more particularly tanks, fractionating towers, piping, and vessels, in the petroleum and chemical industries, which admirably combine high thermal efficiency with improve mechanical application. Basically, this design consists of relatively large size metallic panels filled with insulating material or combination of insulating materials best suited to the particular operation. Figure No. 3 shows several views of 3 ft. 6 in. wide by 100 in. high pre-fabricated panels constructed of sheet steel and expanded metal. The intervening space between the two sides of the panel may be filled, during fabrication, with any material having the most desirable insulating characteristics.

The cost of field assembly for these prefabricated panels represents a fraction of the normal cost and when installed the outer part of the metallic panel forms a waterproof casing and a complete protection against normal mechanical damage. Figure No. 4 shows the application of this design to two hot oil tanks and the scaffolding normally used for this class of work is conspicuous by its absence.

Figure No. 5 shows a similar application to asphalt tanks and simplicity combined with excellent mechanical design is obvious.

The same type of design may be applied to fractionating towers. Openings for large manways and pipe connections are shop-fabricated and field cut-outs for smaller connections present no problem. Figure No. 6 shows an interesting comparison of panel construction and conventional design on vessels used for similar services.

Although this development has been rather recently perfected, installations for temperatures ranging from 20 to 1,000 deg. are being used in the petroleum and allied industries. Present installations include casinghead and hot oil storage tanks, cracking units, piping, acid agitators and other miscellaneous vessels for similar industrial installations. Of special interest to the petroleum refining industry has been the selection of panels filled with aluminum foil and glass wool to insulate the catalyst chambers of several Houdry cracking units now under construction.

These casings or panels have been fabricated from various materials, ranging from aluminum to alloy steel. More generally these panels have been filled with aluminum foil but, in many instances, with aluminum foil in combination with glass wool, rock wool, or other fill type of insulation. Each panel is independently removable and replaceable by means of simple lock joints and the high maintenance cost of replacements and expenses caused by the low salvage value of damaged material have been reduced to a negligible figure.

Appreciation is expressed to the Alfol Insulation Company for their cooperation in the preparation of this article.

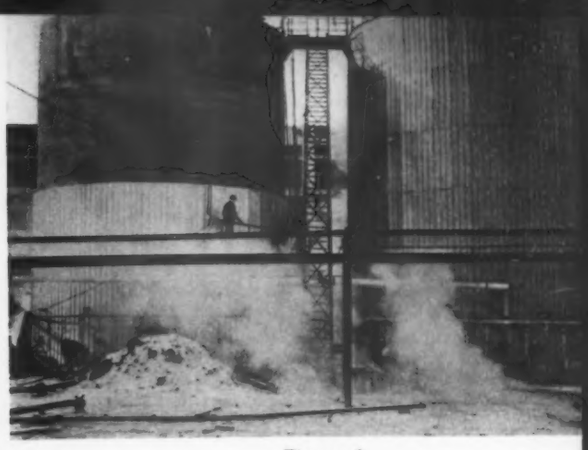


Figure 4.

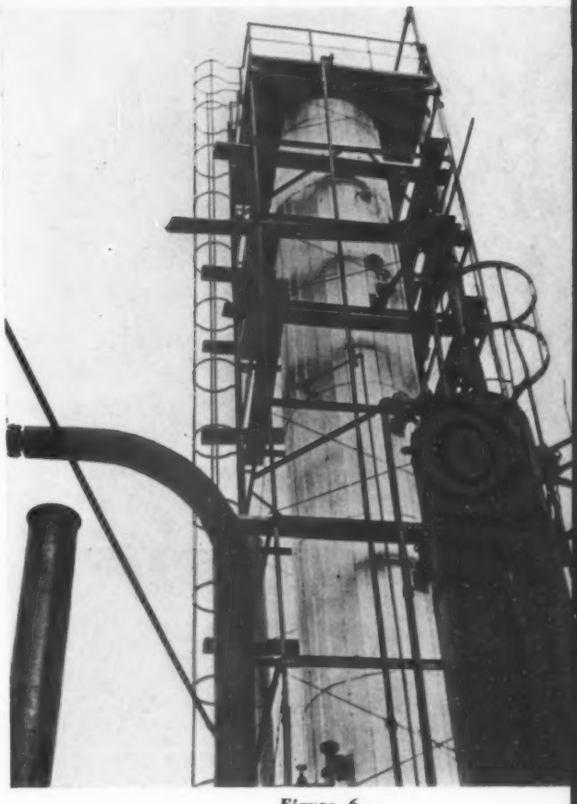


Figure 6.

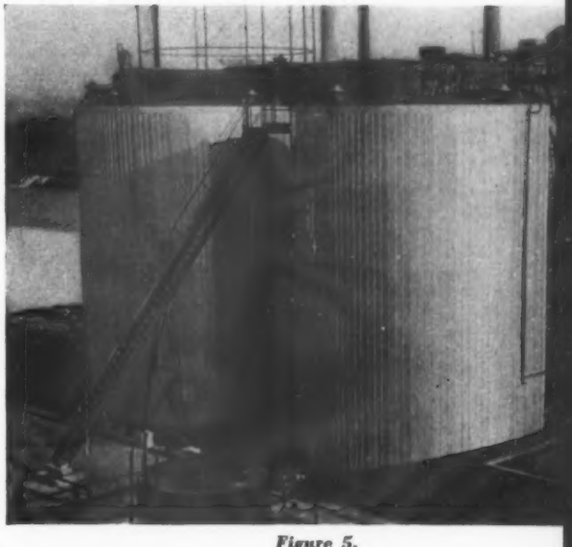
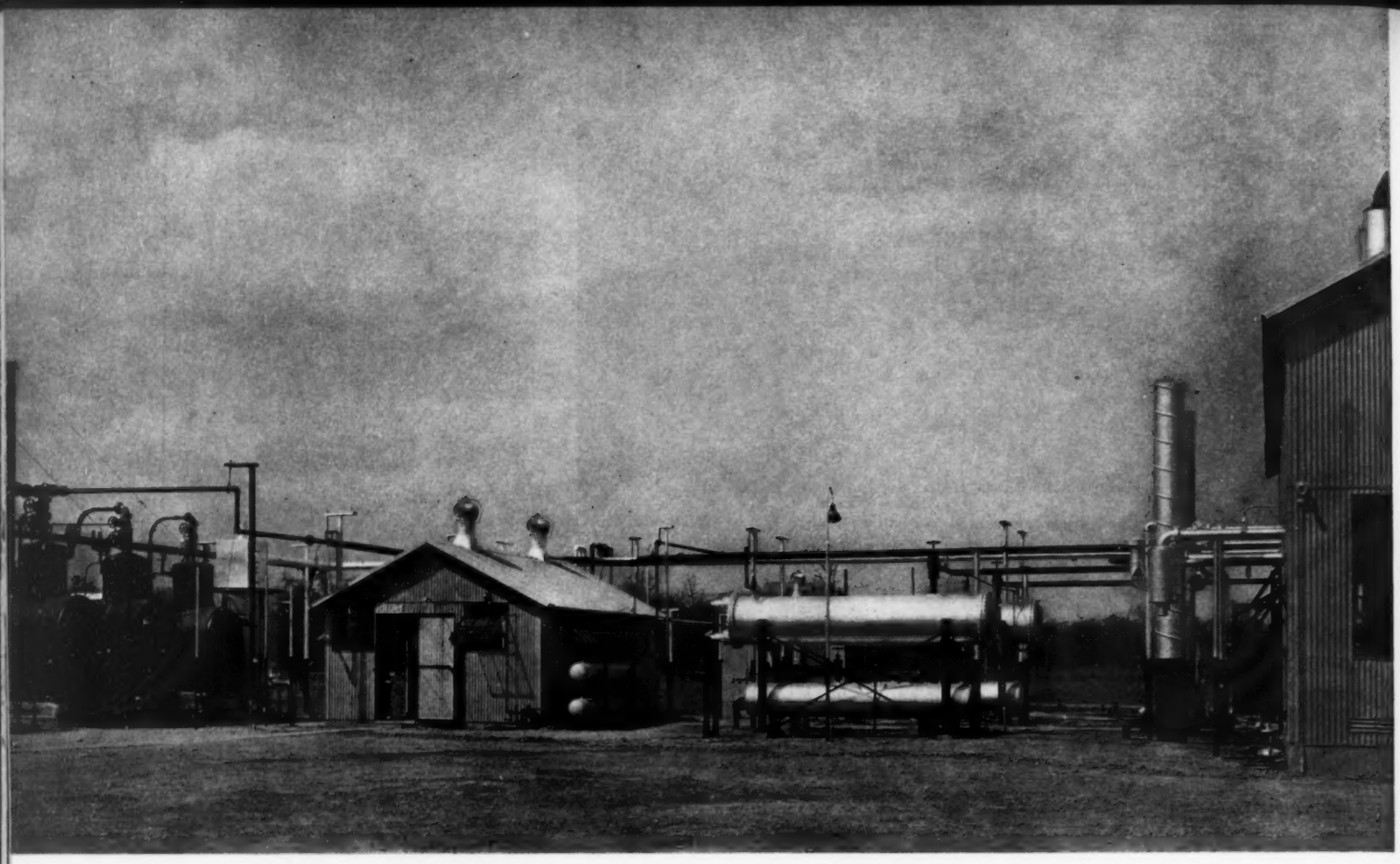


Figure 5.



Boilers, auxiliary room and engine jacket coolers of the Cayuga plant designed by Wm. H. Vaughan of Vaughan Gas Process, Inc., and constructed by J. F. Pritchard and Co. for the Tide Water-Seaboard companies.

CONSERVATION Focused Attention on Economic Possibilities of Pressure Maintenance

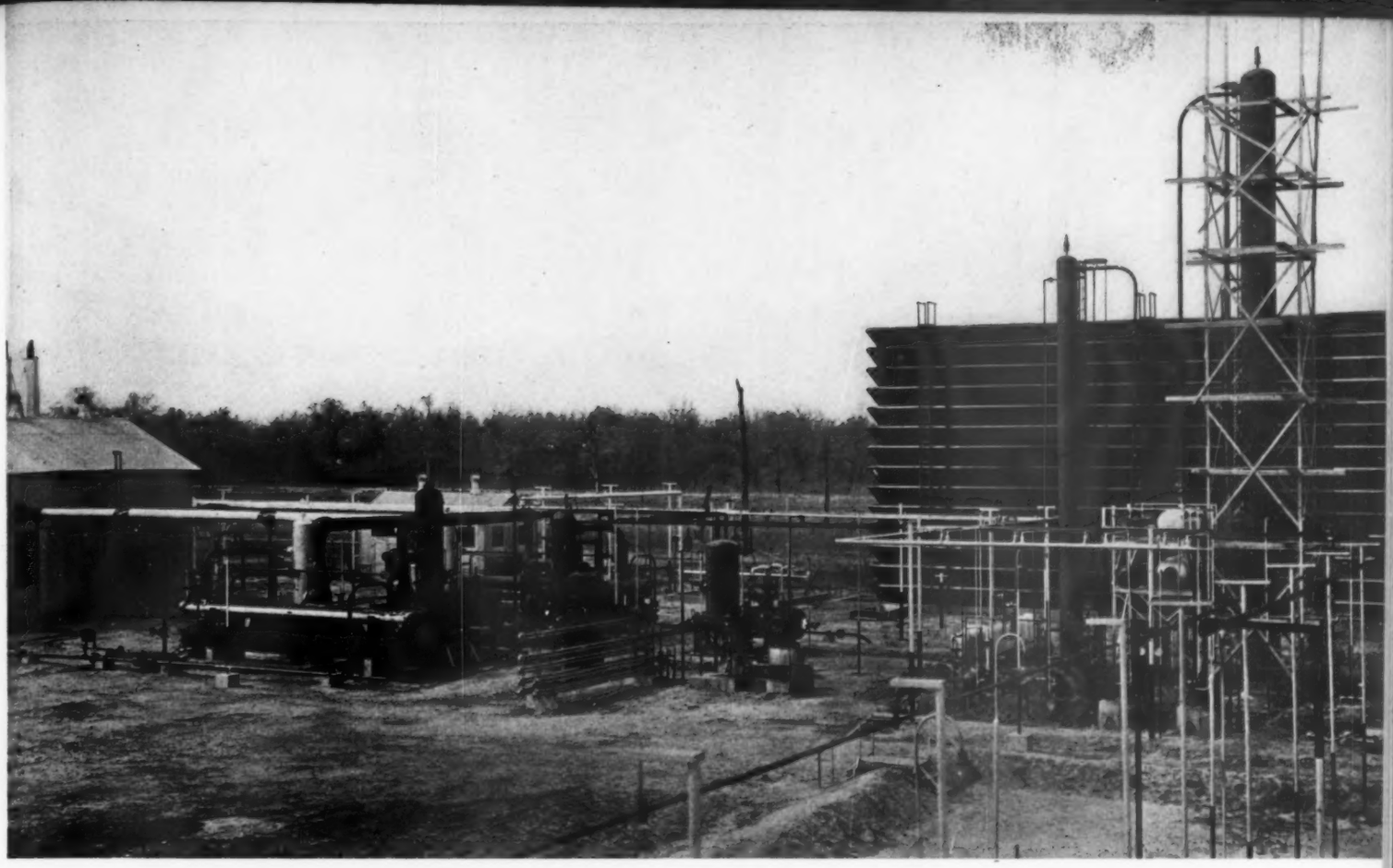
DEEP exploration work along the Gulf Coast has during the past few years brought into production what may now be considered to be a new character of petroleum. It has lately been known as distillate or condensate and has been found in gas from wells of 5,000 to 10,000 ft. in depth and in an area stretching from McAllen, Texas, to the Arkansas line and inland about 250 mi.

The product originally was condensed in the field separator and had the characteristics of natural gasoline, gasoline and kerosene distillate. The producer has come to call this product gas-distillate or condensate. Condensate is an apt name to avoid confusion with distillate, which is a refinery product, but gas-distillate is perhaps the best recognized name for the material at this time. In addition to the condensate trapped in the separator, a substantial quantity of saveable gasoline was not liquefied and escaped with the gas. Condensate recovery per 1,000,000 cu. ft. of gas varies with different pools and occasionally as to wells from the same pool, depending upon their location on the structure. Generally, however, the recovery under the same conditions is the same for wells in a pool. Commercial recovery varies from 10 to 100 bbl. per 1,000,000 cu. ft.

When the regulatory authorities in the State of Texas prohibited the production of distillate unless a legal disposition was made of the gas, they recognized that a gas-distillate well was really a gas well and that the so-called distillate was in the gas phase in the formation. The limitation of the market for gas due to the exceedingly great excess of supply over demand, so restricts the production of distillate under the new regulations that a distillate well is a white elephant. As a result, great interest has been focused on the several plants which have been developed to extract the distillate or condensate from the gas which is then returned to the formation. The extraction may be accomplished with a relatively high degree of efficiency.

In the earlier discoveries, the distillate well was considered as a nuisance, was generally blown wild in the hope that the relief of pressure from the gas cap would permit the production of oil which was thought to lie below the gas. The drop in pressure in the separator tended to knock down a liquid which as recited above would today be considered as distillate. In some cases that separator pressure was employed which produced the smallest volume of gas per barrel of distillate, while in other cases little or no attention was given to this factor. Where a market was available for the gas as fuel, the separator pressure was governed by that required to deliver the gas into the pipeline. In either case the gas, still containing substantial quantities of recoverable distillate, was more than likely not treated for the extraction of these hydrocarbons, and they were lost.

Investigators in the field who observed the behavior of gases from distillate wells presently discovered that the recovery of liquid condensate increased as the separator pressure was decreased from well head pressure, but that presently a point was reached where the volume of condensate decreased and if continued, disappeared altogether; that with different pools and frequently with different wells in the same pool, the pressure at which maximum con-



Complete twin units constructed for Vaughan process treating of 25,000,000 cu. ft. of gas daily at Cayuga, Texas.

densation occurred varied. Finally they found that by cooling the gas to low temperatures increases in condensate were obtained for the same pressure in the separator.

Scientists explain the vaporations of liquid components in a gas mixture upon increase in pressure as a natural phenomenon and one to be expected.

This theory readily explained the decline in condensate yield in those cases where wells had been produced for several years and the gas blown with the air. Where the gas was produced the pressure declined with the result that the heavier constituents condensed in the formation were lost forever to production. When it is considered that the condensibles in the gas in the formation represent from 25 to 120 bbl. per acre foot, it is not surprising that there is little more than enough liquid content to wet the sand grains, not enough to flow to the well to be produced as a liquid.

A text book case of such destruction of a distillate reserve may be cited by referring to the La Blanca field in the Rio Grande Valley. The drop in pressure in that field from 4,000 lb. to 2,180 lb. resulted in a diminution of recoverable content in the gas from 18 bbl. per 1,000,000 cu. ft. to 2.6 bbl.

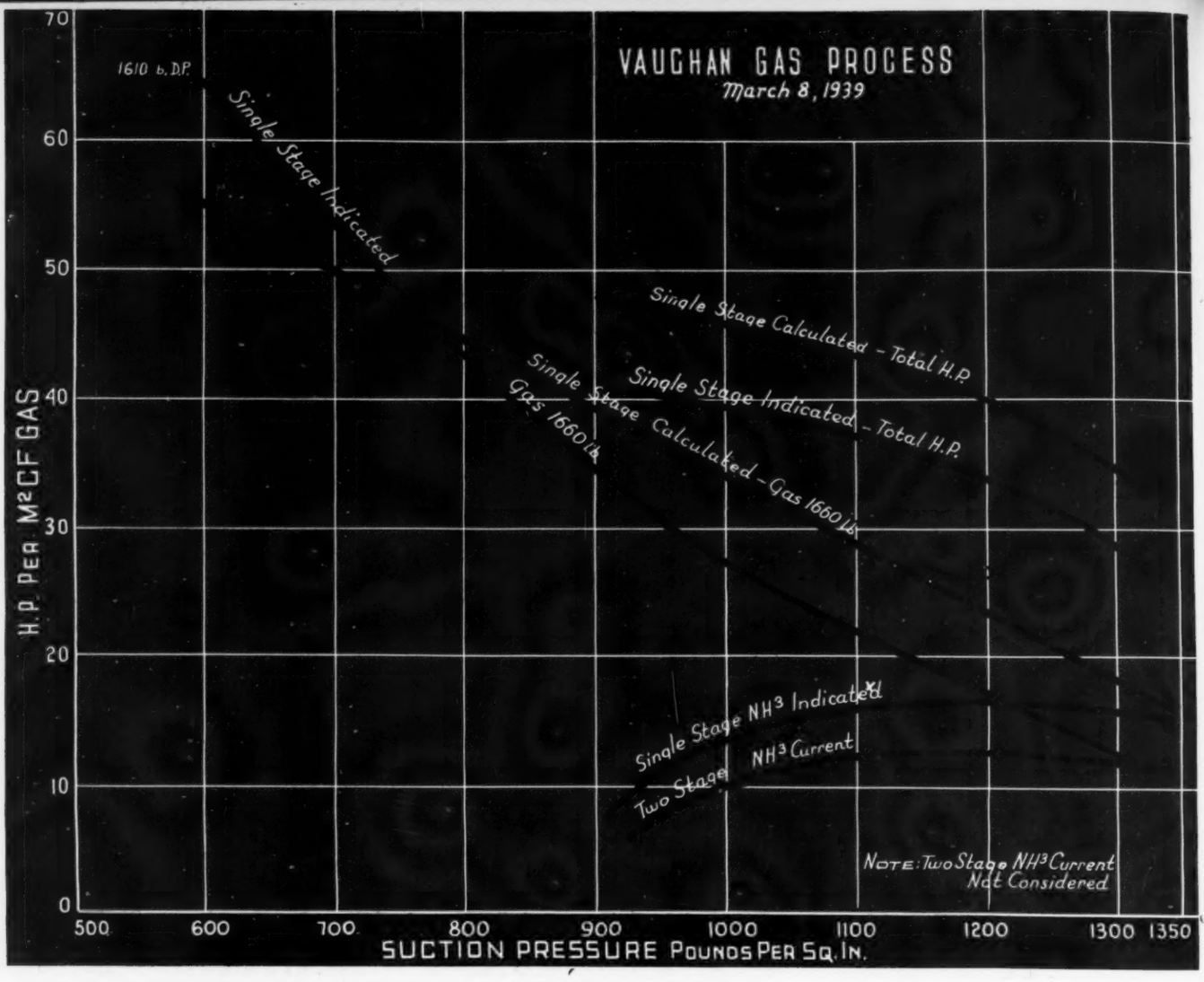
As is frequently the case, some conservation laws prevent the waste of natural resources. When the regulatory body in Texas classified condensate wells as gas wells to prevent the waste of gas as such from these wells, they did more than that. They inadvertently prevented largely the waste of condensate in the formation by preventing relatively rapid pressure decline in the formation. Of course, there will still be a loss in the formation in those cases where gas is sold from this type of field because any taking of gas away from the field results in a pressure decline and in condensation in the formation. The regulations more than anything else directed attention to the waste inherent in permitting pressure drop in these fields, made the proprietary companies take note of the economic loss which accompanied gas production from such fields before the recoverable hydrocarbons were extracted.

Thus it was a combination of the forces of conservation and economics which motivated the petroleum engineer to find or adapt suitable methods of production which would permit the recovery of liquid hydrocarbons in the gas and not do violence to the principles of conservation. He developed what has come to be known as the recycling or pressure maintenance plant. Whatever the detail, the plants are designed to extract the saleable products in the gas at elevated pressure so that the treated gas can be returned to the producing formation without waste and where the gas can be stored against need for the ordinary purposes to which dry natural gas is put.

Although the development program is comparatively new seven plants are already in operation and four under construction. Eight of these plants operate primarily on a cycle of cooling and condensation within the retrograde range.

A flow sheet (pg. 47) shows substantially the operation at the Cayuga plant of the Tide Water-Seaboard Companies at Cayuga, Texas. In this plant the wet gas is cooled by water exchange to 72 deg. F., thereafter by gas exchange with lean gas to 20 deg. F. and finally to minus 4 deg. F. in the ammonia chiller. Water is drawn off in the field separator. In order to preserve all of the refrigeration effect the gas is carried to the plant at as near well-head pressure (1,470 lb.) as possible and is reduced to approximately 1,200 lb. in the extraction separator or accumulator where a temperature of minus 5 to plus 15 deg. is maintained. Any condensate produced in the field separator, is taken either directly to the flash tank or via the gas stream from the final cooler. The lean gas at a temperature of minus 20 to plus 15, is exchanged with the wet gas and passes to the compressor at from 46 to 70 deg. F. Here it is compressed to 1,750 lb. to be returned to the formation. The lean gas may go direct to the compressors.

In some of the plants it is quite practica-



ble to reduce the pressure maintained on the condensate from the separator pressure to atmosphere by several steps. This is called stage separation. Usually three steps are taken to reduce the pressure from 1,200 lb. to atmosphere. Where refrigeration is practiced and indeed where any measure of sub-normal cooling is employed, it does not appear to be practicable to employ stage separation. In a plant like that at Cayuga the condensate is flashed to 250 lb. at O deg. F. Up to this point no appreciable loss is encountered. Vapors from the flash tank have shown by charcoal test a content of 0.025 g.p.m. which is, of course, exceedingly low. The product thereupon is delivered to a conventional stabilizer for reduction to any pre-determined vapor pressure desired by the operator.

Until fairly recently no adequate information was available for plant design in connection with gas coolers or exchangers, vessels, etc. Quotations, from outstanding manufacturers brought bids varying several hundred percent for recommended capacities. Similarly, information on the unit capacities of compressors for the handling of gas at high pressure and low temperatures were unavailable. Through the cooperation of interested manufacturers a substantial amount of data has been developed and made available but considerably more work remains to be done. Plants now in operation are in effect laboratories where those who will may conduct a considerable amount of research. Several interested manufacturers are collaborating to develop information of value from the operation of existing plants.

There has been considerable interest on the part of the industry in the use of ammonia chilling in this plant and in the process generally. Since only two plants are thus far using ammonia the data available as to the economics of low temperature refrigeration is necessarily limited. The experience in the plant described above warrants the conclusion that the use of ammonia for refrigeration is economical.

Vaughan* reported that in this plant substantially the same horsepower was required to handle a given volume of gas from 1,200 lb. to 1,750 lb. at 74 deg. F. as was required to boost gas of a temperature of from 8 to 10 deg. F., the horsepower used in refrigeration having been compensated for by the cooler gas handled. He represented that the additional cooling was reflected by a 41 percent increase in yield, the end product being stage weathered to the same gauge pressure. The cost of refrigeration equipment apart from the compressor in this instance would be fully amortized in approximately six months. Stage weathering being what it is, no accurate information was available to evaluate the finished product in either case in terms of propane of iso-butane content. Since that time a stabilizer has been completed. Plant balances are being taken and the results will be made available.

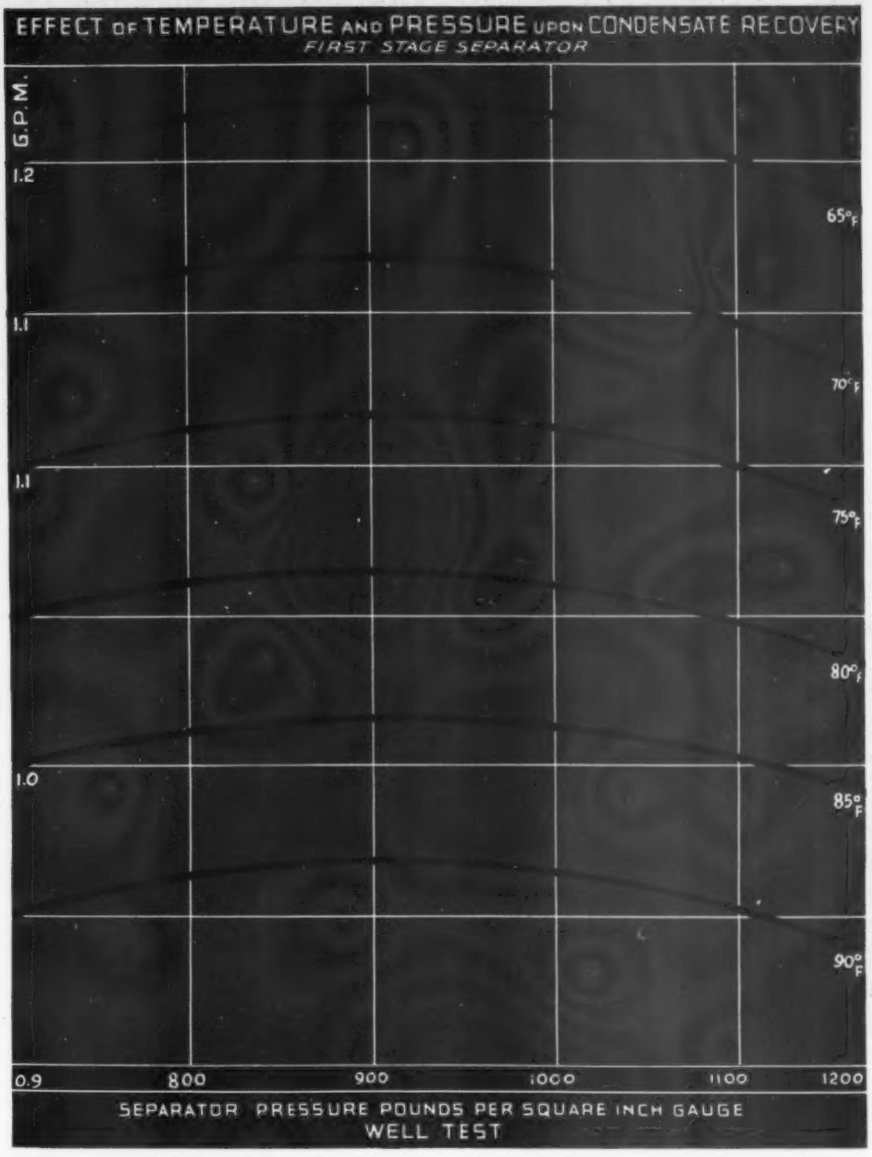
While the production of condensate or gas-distillate is accomplished through recycling plants, the term "recycling" does not truly describe the operation. It is possible that the misuse of this name is responsible for a misunderstanding of the objective of the recycling plant. As a matter of fact, in the ideal project virgin gas will be processed only once, save in those exceptional cases where the gas is rich and where diffusion takes place. After substantially all the gas has been processed once, the project will be discontinued at such time as actual recycling of the gas takes place. In view of this it is highly important that

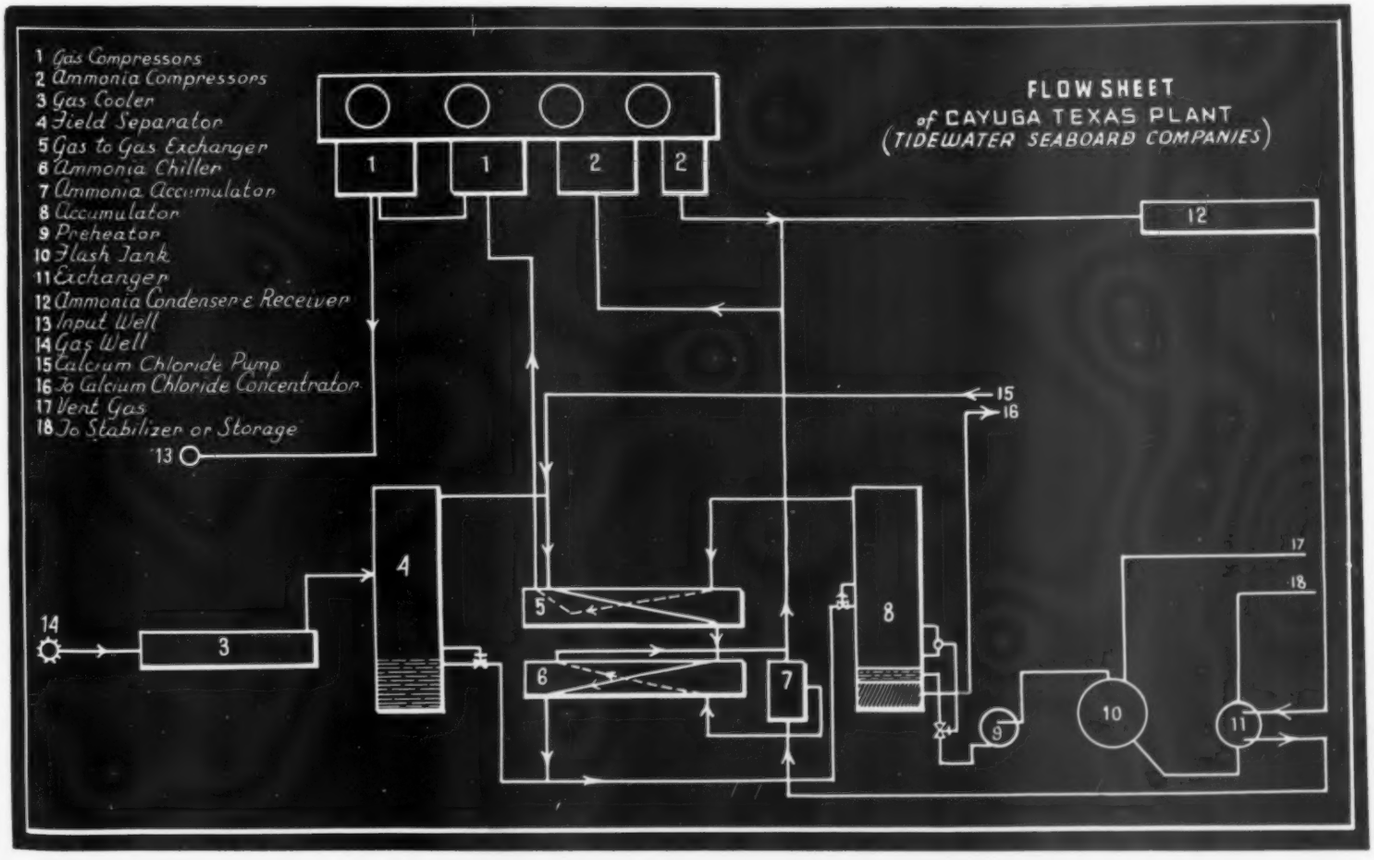
* A. P. I.—Houston, February 28th, 1939

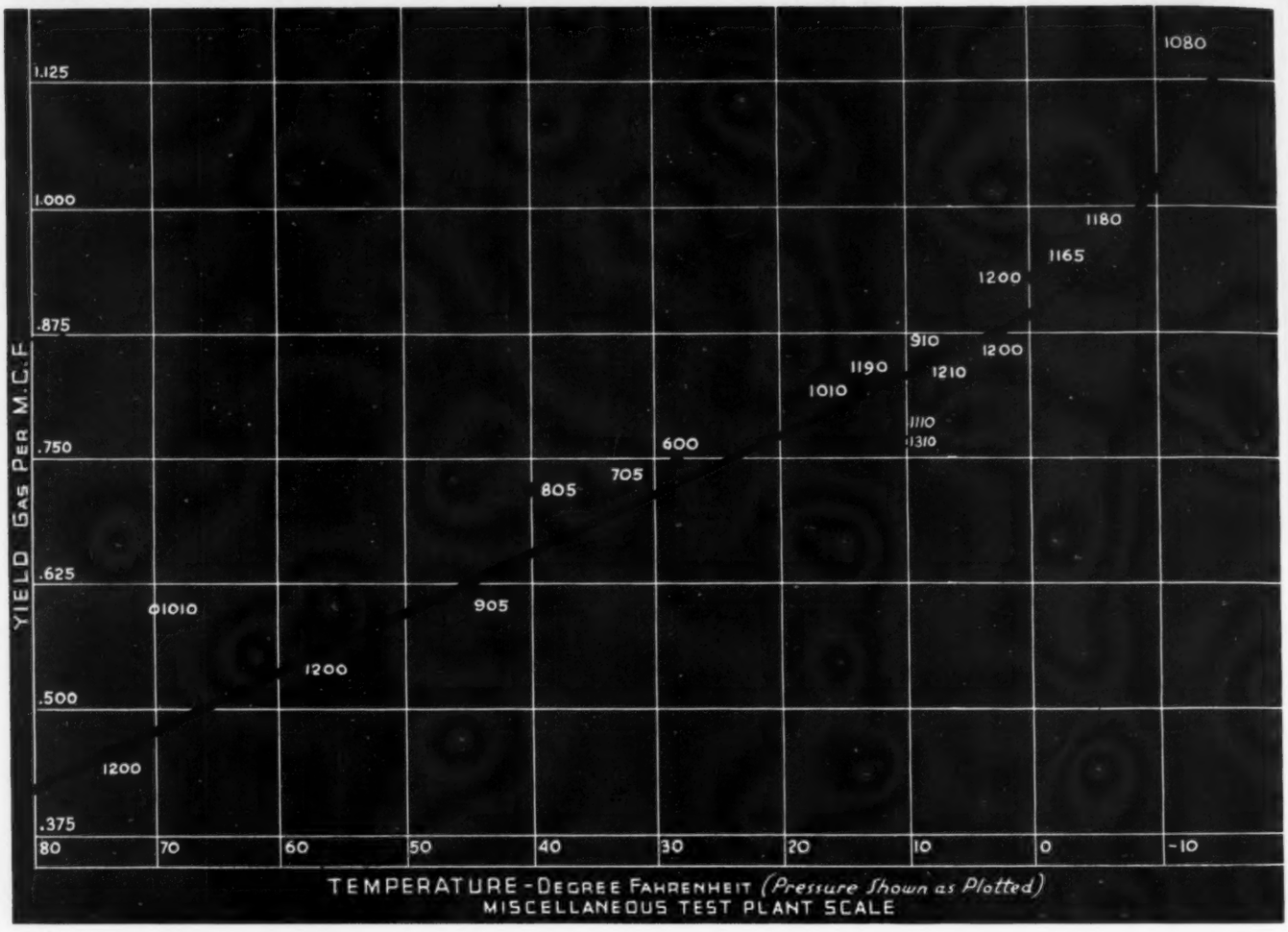
the design of the plant and the well pattern be projected in a manner to make possible the production of all the wet gas without, or at least, with as little diffusion with dry gas as possible and that a plant of maximum efficiency be provided consistent with economics.

In the ideal project, subject of course to geological conditions, it is desirable to drill input walls for the return of the processed gas to the formation at top of the structure and to drill the gas wells on the flanks. This, theoretically at least, permits of the complete purging of the wet gas by the dry gas from above. In other situations substantially the same results may be accomplished by drilling the input wells on one side of the structure and providing for the withdrawal of the wet gas on the other side of the structure.

In either case it is desirable to drill relatively large holes and if the formation permits, to set the casing near the top of the formation leaving as much open hole as possible. Some operators have in the case of their input wells belled out of the hole up to within a foot of the top of the formation and set and cemented the casing at that point. This gives the largest possible input capacity to a well of this character. A large hole for a gas producer permits the production of gas from the well without creating a pressure drop near the bore of the well. A pressure gradient in some cases will tend to be sufficient to cause the condensation of the heavier fractions in the gas. The large hole makes possible the production and the delivery of gas to the plant with a minimum pressure drop from the formation.





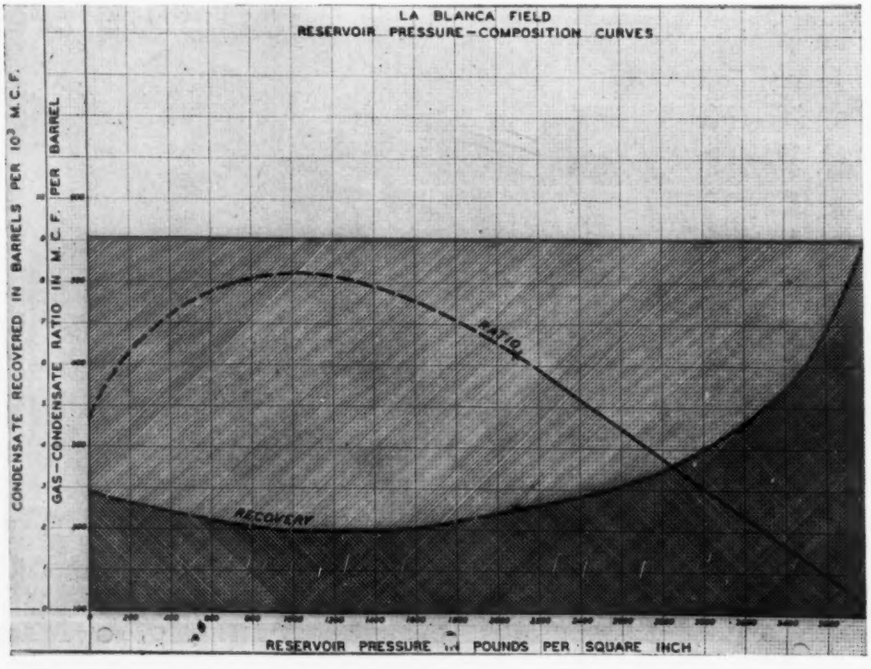


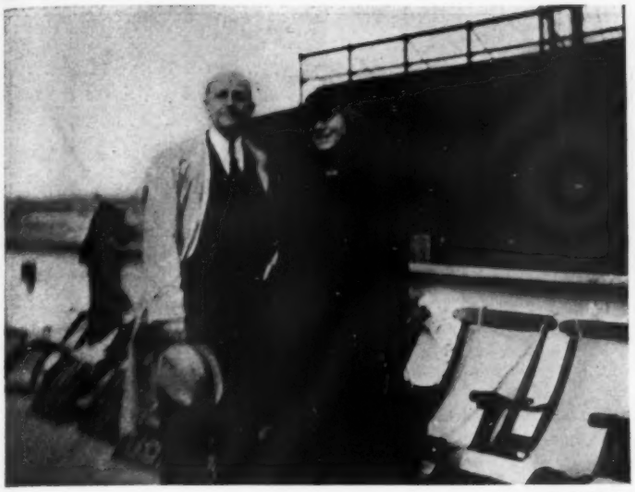
While various factors affect the cost of developing gas distillate production through a recycling plant, it is possible to lay down a general formula for cost which justifies the project. The profitability of the plant will of course vary with the realization and with the character of distillate produced. Some fields yield a product which falls entirely within the natural gasoline and motor fuel range whereas other fields yield a product, part of which at least, is in the kerosene or distillate range. Generally speaking, the recoverable hydrocarbon content should be 18 bbl. per 1,000,000 cu. ft. The plant and wells supplying the gas and including the wells for the return of the processed gas should not exceed a cost of $20 per gal. of condensate production capacity.

It is obvious from what has gone before that any gas reservoir which may be commercially exploited for gas-distillate production should have all of the gas produced returned to the formation. Where sales are absolutely necessary they should be held to a minimum. It has been sufficiently demonstrated that the lost distillate within the reservoir is the result of the extensiveness of the pressure drop in the formation and not of the rate of that drop. Every diminution in pressure results in the condensation of progressively lighter fractions in the gas and their loss to ultimate production.

It has been estimated that there is at the present time more gas-distillate production than the amount of natural gasoline produced daily in the United States. Only a small part of this production is obtained through recycling plants.

It is to be expected that in an operation as new as recycling a great deal of improvement will be made in the process now in operation or under development. While the problems incident to the development of the recycling process concerned but few elements in the industry, today they are engaging the attention of a great many producing companies as well as engineering companies. It is therefore not unreasonable to expect improvements as a result of the increasing efforts being brought to bear upon the development of this newest phase of production or manufacturing practice in the oil industry.


LA BLANCA FIELD
RESERVOIR PRESSURE - COMPOSITION CURVES
CONDENSATE RECOVERED IN BARRELS PER 10³ M.C.F.
GAS - CONDENSATE RATIO IN M.C.F. PER BARREL
RATIO
RECOVERY
RESERVOIR PRESSURE IN POUNDS PER SQUARE INCH



W.P. Staff Photo

C. W. Hamilton (Gulf Oil) snapped as he took Mrs. Hamilton around the ship.

Foreign Oil Legion

C. W. HAMILTON, vice-president of Gulf Oil Corporation, and JAMES M. GREER, counsel for South America for Gulf and its subsidiaries, left New York on board the SANTA PAULA March 31st en route for Caracas, Venezuela, where they will remain for about a month in connection with legal affairs of the Gulf interests.

CARL COOK, official of Humble Oil and Refining Company, of Houston, also sailed from New York on board the SANTA PAULA en route to Venezuela.

PRESIDENT MANUEL L. QUEZON, of the Philippine Islands, disclosed in a recent press conference, that an initial outlay of P500,000 would be required to finance the survey and exploration of potential oilfields during the first year of operation of the National Development Company. He had previously rejected the bid of Standard Vacuum Oil Company to undertake the exploration and development of the nation's potential oilfields which has been taken over by DR. H. FOSTER BAIN, Commonwealth adviser on mining, and QUIRICO ABADILLA, director of mines. The president declared that he rejected the bid submitted by Standard Vacuum because of the inclusion of a condition not in the advertised call for bids: that in case of litigation involving the lease and development contract or the ownership of the oilfields, the contracting firm reserved the right to suspend work on the oilfields. He said that it was too much of a concession to the operator because it would be easy to bring suit and thus suspend the timely development of oil-bearing properties; that inclusion of the clause had been done in best of good faith, but that it was his duty to protect the public interests in matters of the kind.

W.P. Staff Photo

James M. Greer (Gulf Oil) leaves his friends a moment to speak to our photographer.

S. H. RUSSELL, who has been in Turkey for several years drilling test wells for the Turkish government mining department, is visiting friends in Texas prior to his return to the Near East.

C. M. DAVIDSON, manager of wholesale lubricants, and J. M. de Luna, European marketing assistant, Standard Oil Company of New Jersey, sailed for Europe on board the liner PARIS April 8th.

W.P. Staff Photo

W. A. Stewman (Bahrein Petroleum).

W. A. STEWMAN, driller for the Bahrein Petroleum Company Ltd. at Awali, Bahrein Is., Persian Gulf, recently passed through New York en route to his home in Abilene, Texas, on three months leave.

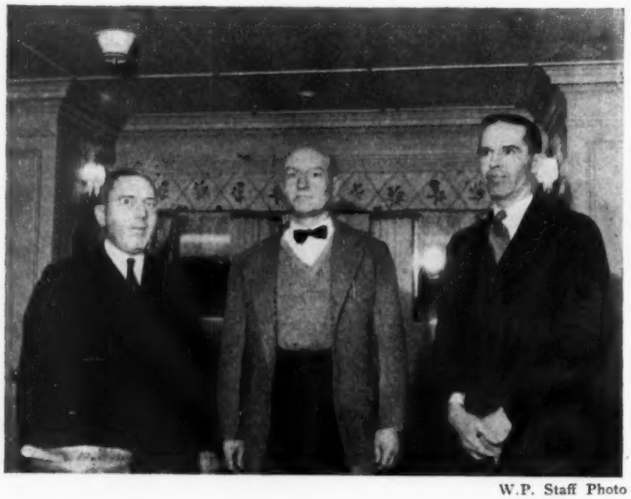
C. K. MCCLELLAND of Standard-Vacuum Oil Company, for the past year in Manila, Philippines, returned to California on the President Coolidge March 2nd en route to his home in Meadville, Pennsylvania, for a few months visit. He was in oversaes service (Far East and Australia) for 19 years with Standard and Standard-Vacuum.

ALEXANDER FRASER, president of Shell Petroleum Corporation, St. Louis, sailed from New York en route to London on board the NORMANDIE on March 3rd.

ROBERT ROESSLE, head of the overseas personnel department of Standard Oil Company of New Jersey, recently returned from a month trip to Caribbean properties of the company. With him on his departure from New York were RALPH MASON, industrial relations superintendent of Jersey Standard, and FRED BIMEL, of International Petroleum Company's manufacturing department.

Henry M. Dawes, president of Pure Oil Company, is a well-known figure in the American oil industry.

W.P. Staff Photo



Fred Bimel (International Petroleum), Robert Roessle and Ralph Mason (Jersey Standard) photographed in their suite on board the Santa Paula.

W.P. Staff Photo

BUFORD W. DAVIDSON, export sales manager for M. O. Johnston Oil Field Service Corporation, was the victim of an airplane crash near Karachi, India, on February 23rd. The accident, which cost Mr. Davidson his life, occurred near the half-way mark on an extended trip around the world which he was making in the interests of his company. He was en route from Bahrein to Lahore when the accident occurred.

WM. C. MCDUFFIE, formerly receiver of Richfield Oil Company of California, and now independent holder of the Ganso Azul concession in Eastern Peru, sailed from New York April 20 on the s.s. WASHINGTON for a brief visit in London in connection with the affairs of the Peruvian Company. The "Blue Goose" structure was considered proven in February, when a 2500-bbl. well of 43.7 deg. gravity oil was brought in at 1,300 ft.

M. A. HUFFMAN, assistant superintendent in the Maracaibo Lake basin for Mene Grande Oil Company, left New York on board the SANTA ROSA March 3rd en route to Venezuela. During his stay in the United States he had attended the Rose Parade and New Year's football game in Pasadena, California, with Mr. and Mrs. I. Frank Brown.

MARCEL SCHLUMBERGER, president, and MAURICE SCHLUMBERGER, director, of Société Prospection Electrique, of Paris, arrived in New York February 21st, and after a brief trip through the United States returned to France on board the ILE DE FRANCE March 18th.

HON. FRANCIS J. HOPWOOD, executive of Asiatic Petroleum Company Ltd., London, sailed from New York with Mrs. Hopwood on board the SANTA ROSA March 24th en route to Caracas, Venezuela. Mr. Hopwood is in charge of the Venezuelan interests of Royal Dutch-Shell.

HARVEY L. DREW, for many years with Lago Petroleum Company in Maracaibo and National Supply in various parts of South America, recently joined the organization of I. Frank Brown. He is now making a trip through California and Mid-Continent fields prior to an extended stay in South America.

Colonel and Mrs. Frank Drake being greeted by movie actor Conrad Nagel (in grey coat) when they arrived in Hollywood to inaugurate the new Gulf-Screen Guild Show radio series.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Stratigraphy and Structural History of East-Central United States—Norval Ballard, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 22 (1938), No. 11, pp. 1519-1559.

This article contains a discussion of the regional stratigraphic changes as revealed from studies of outcrops and cuttings from approximately 525 wells in Michigan, Ohio, Indiana, Illinois, Kentucky, and Tennessee. Three east-west cross sections have been prepared in order to show graphically these structural and stratigraphic changes. A tentative correlation table and seven logs made from studies of well cuttings are included as an aid to future students in the area.

The structural history which began in pre-Cambrian time, continued with minor pulsations in post-Canadian, post-St. Peter, post-Brassfield, post-Chattanooga, post-St. Genevieve, and post-Pennsylvanian time. One major period of folding occurred in post-Mississippian pre-Pennsylvanian time.

Comparison of Upper Cretaceous Deposits of Gulf Region and Western Interior Region—Lloyd W. Stephenson and John B. Reeside, Jr., in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 22 (1938), No. 12, pp. 1629-1657.

The Upper Cretaceous deposits of the Gulf region are mainly of marine origin. Taking the east-central Texas section as a standard, the deposits present different sequences of units from place to place in both directions away from this section, both to the southwest and to the northeast. The sequence in east-central Texas resembles that in the Great Plains of the western interior. No other sequences in the two regions are similar to each other.

The Upper Cretaceous of the western interior may be roughly divided into belts representing three types of sequence: the Great Plains sequence—mainly fine sediments, and of marine origin; the Rocky Mountain sequence—continental and marine sediments, much sandstone, considerable coal, increasing in coarseness westward; and a western marginal belt dominantly nonmarine, coarse sandstones, conglomerates, and coals; sequence usually incomplete.

Fossils are abundant in both regions. Although many species are present in each region that are not found in the other, enough of them are common or closely analogous to permit a fairly close correlation of the deposits. Dependence for correlation is placed chiefly on the mollusks.

Although there is at present no physical connection between the Upper Cretaceous deposits of the Gulf region and those of the western interior, the presence of common and closely analogous species throughout the series in the two areas indicates that there was such a connection. Presumably the connecting deposits that once existed in some part of the area now separating the two regions have been removed by erosion.

Carterville-Sarepta and Shongaloo Fields, Louisiana—G. D. Thomas in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 22 (1938), No. 11, pp. 1473-1503.

The Shongaloo and Carterville-Sarepta oil and gas fields are located in the north part of Bossier and Webster parishes, Louisiana, just south of the Arkansas-Louisiana state line. The Shongaloo field was discovered in March, 1921, and the Carterville-Sarepta gas was discovered in January, 1922, although oil was not discovered at Sarepta until 1924, and at Carterville until September, 1929.

The Shongaloo field is a dome-like structure, elongated east and west. The Carterville-Sarepta anticline lies immediately west of Shongaloo and consists of six small local closures along the main northwest-southeast axis of this anticline.

The Buckrange sand at 2,650 ft. and two sands in the uppermost Tokio at 3,050 and 3,150 ft. produce gas and oil at Carterville although only the Buckrange sand is productive at Shongaloo. The amount and extent of oil and gas is governed as much by variations in porosity and thickness of these three sands as by structure.

The disappointing recoveries of gas and oil per acre were due in a small degree to lack of great structural relief but in a large degree to lack of continuity and sufficient thickness of these three oil and gas horizons. Faulting can not be recognized from present data on these structures. The structures are generally believed to be the result of a local small amount of flowage of salt beds which underlie sediments of early Comanche or older age in north Louisiana and part of south Arkansas. Beds older than middle Glen Rose have not been tested in either field.

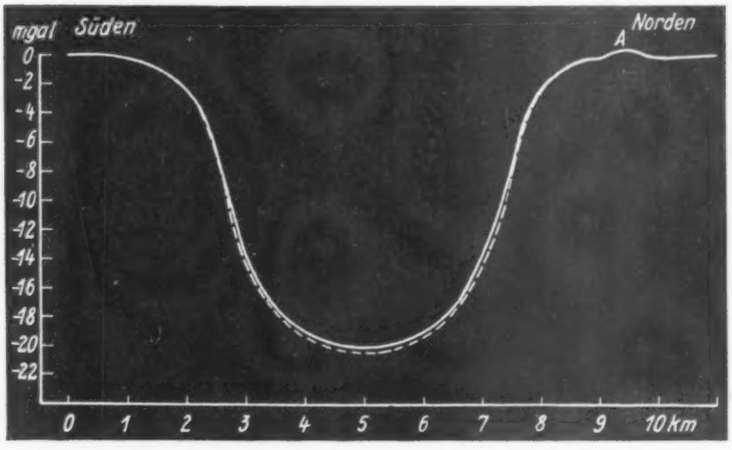
The results of the deep test now drilling at Shongaloo will have an important bearing on possible deeper drilling at Carterville-Sarepta.

New Apparatus for Rapid Determination of Velocity of Elastic Waves in Well Cores—Stephan Baron v. Thyssen-Bornemisza in OEL UND KOHLE, Vol. 14 (1938), No. 46, pp. 960-962.

A new apparatus is invented by which the velocity of longitudal waves can be measured directly on any sort of material taken by coring, provided the material has a certain homogeneity. The method depends on the principle of inducing, by means of resonance, a characteristic basal elastic vibration in the material and measuring the lengths of these elastic waves. The results are entirely comparable with those obtained by seismic methods in practice. This is of some importance to geologists and geophysicists, in that samples can be investigated on the spot in their natural moist condition. The apparatus is easily transportable, and may be connected to any 110 or 220 volt electrical circuit. A determination requires only a few minutes.

Influence of Scale Accuracy on Gravimetric Measurements—A Schleusener, in OEL UND KOHLE, Vol. 14 (1938), No. 46, pp. 957-959.

In gravimetric measurements for purposes of applied geophysics it is possible to over-estimate the importance of scale accuracy. Gravimeters of German make are calibrated on a line between Harzburg and Torfhaus where the maximum error does not exceed 0.4 or 0.5 mgal; in the most unfavorable case an instrument calibrated on this line will be correct within 0.5 percent, a range of error which is entirely negligible in practice, as may be seen from the accompanying diagram. This diagram represents a south-north gravity gradient across a buried salt dome. The solid line represents the absolute value of gravity in milligals; the broken line represents the gradient where the scale of the gravimeter is erroneous to the extent of plus two percent.



DRILLING

Drilling With Reverse Oil Circulation in Wider Use—F. G. Beckman, in OIL WEEKLY, Vol. 91 (1938), No. 13, pp. 19-20, 21, 24, 26.

The practice of completing wells by the reverse circulation method in which the circulating fluid passes down through the space between casing and drill pipe and up and out through the drill pipe, instead of vice versa, is being more and more extended. The advantages of the method are becoming better known, and are considerable. Among them is the fact that the power required to circulate the fluid is only about 1/125 hp. Another is the extreme accuracy of logging the well. Formations of only one or two inches in thickness can be logged to within the accuracy of measuring the downward movement of the drill stem.

A special application of the reverse method is in the use of oil as the circulating fluid when completing wells, and in cleaning out old wells. During the last two years, in completing approximately 600 contracts of drilling-in and cleaning out wells, the following observations and conclusions have been made: In penetrating stratas of chalk, hard and soft shale, and lava ash or bentonitic deposit, it has been found in all cases that these formations were in a perfectly dry and firm state. There has not been any apparent break-down of these formations in oil, while it is a known fact that all these formations will break down to mud or gumbo when in contact with the water or drilling mud. While experience has been somewhat limited in drilling formations that will heave and cave with water, either with rotary or cable tools, they do not show any signs of caving or heaving when drilling with oil.

Electric Energy Consumption in Rotary Drilling—W. H. Stueve, in PETROLEUM ENGINEER, vol. 10 (1938), No. 2, pp. 33-36.

Data for an estimate of the power requirement and possible cost of alternating current for drilling oil wells was obtained from the books of a large public utility company operating in Mid-Continent oil fields. The oil wells represented in the survey included holes from 2,000 to 7,000 ft.; the deepest well drilled by A-C power converted to D-C power is 11,084 ft.; the total footage drilled exceeded 160 mi. The data are summarized in the accompanying table.

Approximate depth in ft., number of wells drilled, total kw-hr. sold, and average kw-hr. per well (Rotary drilling)

Approximate depth, ft.	Number of wells drilled, 1933 to 1937	Total footage drilled	Total kilowatt-hours sold	Average requirements, kw.-hr. per well
2000	30	60,000	1,136,469	37,882
3000	2	6,000	130,400	65,200
3375	1	3,375	60,100	60,100
3910	7	27,375	749,900	107,100
4200	92	386,400	8,636,551	93,876
5200	37	192,400	5,322,180	143,843
6500	14	91,000	2,889,200	206,371
6800	9	61,200	2,004,640	222,738
7000	3	21,000	745,080	248,360
	195	848,750	21,674,520	

No attempt has been made to indicate the wells consuming maximum or minimum power. Thus, although wells drilled to a depth of 4,200 ft. required an average of 93,876 kw.-hr., a few are known to have consumed as much as 140,000 kw.-hr. and a few as little as 75,000 kw.-hr. It is almost impossible to determine the reason for this difference unless the details of formations drilled and fishing jobs attempted are available. Some crooked holes are drilled, whipstocks are used to straighten holes, and tools and drilling bits become stuck requiring slow milling operations, all of which will distort the resultant data. On the whole, however, by plotting an average curve from this data a close approximation may be obtained.

Electric Drilling and Pumping Costs—PETROLEUM WORLD (Calif.), Vol. 35 (1938), No. 11, pp. 46-48.

According to figures presented before the Pacific Coast Electric Association, the cost of drilling a well requiring 90 days for completion is:

FOR STEAM RIG—	
Transportation (20 mi. at 5c a ton mile)	$ 94.80
Erection of equipment	3,000.00
Total operating expenses (90x234.50)	21,105.00
	$24,199.80
FOR ELECTRIC RIG—	
Transportation (20 mi. at 5c a ton mile)	$ 49.50
Construction of electric service line	780.00
Erection of equipment	1,200.00
Total operating expenses (90x196.47)	16,782.30
	$18,811.80

or a saving per well for the electric rig of $5,383.00. On the basis of drilling three such wells per year, the electric rig will show a saving of approximately $17,164 per year. The cost data given did not take into consideration scarcity of water, bad water, treating of water or excessive maintenance due to bad water.

Another group of figures relates to the cost of electrically pumping 91 wells ranging in depth from 500 to 4,500 ft. and producing from three to 850 bbl. of fluid per day in eight California fields. These wells are divided into efficiently operated and inefficiently operated groups. The costs of the first group for a given production averaged $26.38, and of the second group $36.25.

Principal reason for high costs in the latter group was found to be over-pumping; i.e., longer stroke and higher r.p.m. for lower volume. Contributing reasons were poor counter-balancing, defective pumping equipment and over-sized motors. Another fault where double rated variable speed motors were used was the operation of motors below maximum speed, rather than changing gears.

Cementing Jobs for Shutting Off Salt Water—Phil Montgomery, in OIL WEEKLY, vol. 92 (1938), No. 1, pp. 34, 36, 38, 42.

A survey of the East Texas oilfield shows that cementing jobs for shutting off salt water may be classified into four groups with a total of 12 methods.

Group 1—Straight plug-back jobs: (a)—The cement plug is cut off below the top of the oil sand; (b)—The top of the cement plug is cut off up in the casing.

Group 2—Braden-head squeeze job: (a)—The top of the cement plug is cut off below the top of the oil sand; (b)—The top of the cement plug is left extended up into the casing after cement has been squeezed into the formation; (c)—The cement is pumped under pressure and the excess is pumped out through an adjustable flow bean.

Group 3—Retainer squeeze job: (a)—The production string is cemented above the oil sand; (b)—Using tail pipe, where the production string is cemented above the oil sand; (c)—Cementing through shot holes; (d)—Cementing through a perforated liner or cementing off salt water in a well where a full hole cementer has been used.

Group 4—Short string job: (a)—Where short string is used to cement off a heaving formation between the bottom of the casing and the top of the oil sand; (b)—Short string squeeze job using Braden head; (c)—Short string job using a special tool to keep the pressure off the casing.

The cement used is mostly slow setting. Quite lately gel-forming cements have been coming into use, all containing bentonite or a similar colloid. A pressure of 3000 lb. toward the end of the pumping operation is desirable and special methods are employed to obtain this pressure. These slow-setting gel cements have proved to be a big forward step.

No one of these cementing jobs will meet all requirements; where wells are making a high percentage of salt water the retainer squeeze jobs and the short string squeeze jobs have been the most successful.

NATURAL GAS

New Progress in the Field of Desorption Gas Analysis—Rudolph Henjes, in OEL UND KOHLE, Vol. 14 (1938), No. 47, pp. 1079-1083.

This important research introduces a new principle into the analysis of hydrocarbon gases. This principle is that the gases differ in their heat conductivities, a property that can be used to measure their relative proportions in a gas mixture.

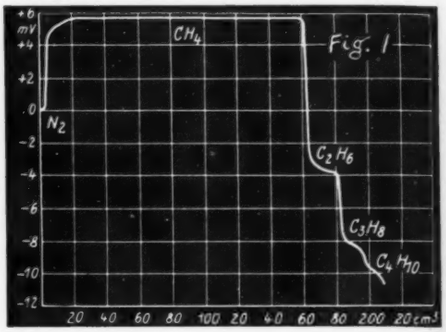


Fig. 1

In applying this principle to gas analysis advantage is taken of the adsorptive properties of activated carbon. When a mixture of the hydrocarbon gases is led over such carbon at a suitable temperature the different components will be adsorbed or condensed in the same proportions as they are contained in the gas mixture. When the carbon containing the adsorbed gases is now heated the most volatile constituent will be expelled first, then the next highest boiling component, and so on.

The new method of gas analysis takes advantage of this selective desorption. For example, when the carbon has been saturated with a gas mixture consisting of methane, ethane, propane and butane, the methane will be given off first and the heat conductivity of the issuing gas will be characteristic of methane. When all the methane has been expelled, gaseous ethane will then appear and the heat conductivity of the issuing gas will show a radical change. Next to appear will be propane, which has a different heat conductivity, and finally the characteristic heat conductivity of butane will show itself. See Fig. 1.

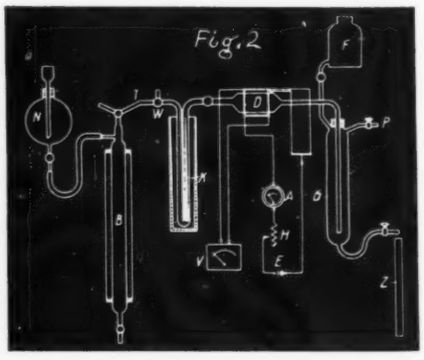


Fig. 2

Each of these changes in heat conductivity of the issuing gas can be recognized by a change in the electrical conductivity of a set of wires bathed by the gas. For details of the apparatus and its manipulation the original article should be consulted, but an idea of the layout may be had from Fig. 2. The gas

Tidewater Associated and Seaboard Oil companies have chosen G-MV and G-MR compressor units for their new re-cycling plant at Long Lake, Texas. Built for these partners-in-development, by J. F. Pritchard and under Vaughn Process plans, this new plant marks another forward step in modern refinery practice.

Cooper-Bessemer angle and "V" type compressor units are getting the nod in many new plants because they are designed and built for just such service. Costs are always important in profits . . . not just first costs . . . and that is why Cooper-Bessemer units are chosen. There are no finer compressors for compactness, long-life, over-all operating economy, and freedom from costly shutdowns.

Re-cycling, re-pressuring, pressure-maintenance . . . whatever your job . . . investigate Cooper-Bessemer compressors for the better way to do it!

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Magnolia Bldg., Dallas, Texas
529 M & M Bldg., Houston, Texas

to be analyzed is measured in the vessel B, and adsorbed in the specially constructed carbon chamber K. The desorbed gas passes through the wired chamber D, where it affects the electric circuit which includes a battery E, an ammeter A, a heat resistance H. and a millivoltmeter V. The gas passes on to the cooling chamber G where it is liquefied and measured. By noting the volume of condensate at each change of conductivity registered by the electrical circuit the volume percentage of each component is ascertained.

An analysis such as is shown in Fig. 1 can be completed within 1½ hours. The separations are very sharp up to and including butane. The higher homologs are not so clearly separated. Mixtures of the lower olefines also show sharp separations. Helium in petroleum gases can be estimated with great precision.

REFINING

Motor Fuel Demands of the Modern Automobile Engine—W. W. Scheumann before WESTERN PETROLEUM REFINERS ASSOCIATION, Shreveport Meeting, 1938.

It is a custom of the automobile manufacturers to put out new and if possible improved models every year. These improvements are along certain quite definite lines: decrease of engine weight per orsep wer, increase in average maximum brake horsepower, increase in maximum engine speed, increase in average compression ratio, and increase in effective brake pressure. What particularly affects the petroleum refiner is that, as the automobile engine becomes mechanically more perfect, demand is made for an engine fuel of better and better quality, chiefly as regards anti-knock value and volatility with avoidance of vapor-lock.

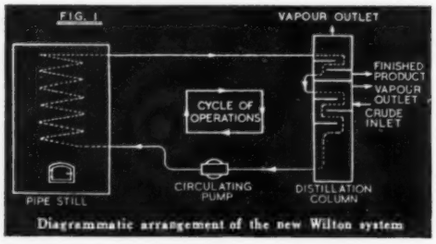
From an over-all viewpoint, it is necessary that, in order to make satisfactory motor fuel, the refiner of today must produce a base gasoline not only by the skimming of crude, but also by extensive cracking, polymerization, and other methods in order to produce a base gasoline of high natural octane number. To this, sufficient tetraethyl lead must be added to meet accepted sales quality standards. In addition, the fuel must also meet accepted volatility requirements. The trend in these demands shows little let-up of increasing severity and the successful accomplishment of these objectives demands that the refiner carry out continuous research work of a wide scope and continuously modernize his equipment and manufacturing methods to maintain his position.

All of these operations involve added expenses, which normally should be reflected in gasoline prices. This has not been the case, however, and, while the modern engine can hardly be blamed for the refiner's failure to secure an adequate return for the improvements he has made in motor fuels, nevertheless this unsatisfactory economic condition greatly adds to the refiner's burden.

The price trend of gasoline has not kept pace with the price trend of crude oil. The refiner is, therefore, faced with a condition whereby the cost of his raw material has increased faster than the selling price of his product. In addition, manufacturing expenses have increased, due to increased cracking and reforming, the use of lead, higher labor rates, and similar items. To carry out these operations, tremendous capital investments have been made in equipment with resulting high depreciation and interest charges. All of these items, therefore, mean a higher manufacturing cost. As offsetting features, this newer equipment is much more efficient and has thereby effected some reductions in cost due to better fuel economy and higher recovery. The refiner who has not been able to install new equipment and modernize his old, finds himself in a difficult position and can only hope to subsidize his manufacture of motor fuel from revenues derived from other products or operations.

New System of Combined Distillation and Fractionation — Horace Priest in PETROLEUM TIMES, Vol. 40 (1938), No. 1036, pp. 669-672; 675.

Pipe-stills handling a low throughput cannot be constructed bacause a small pipe-still coil has too small a bore to produce the necessary turbulence of the flowing oil. The new Wilton system embodies recirculation of the residuum through the pipe-still so that the necessary turbulence is created irrespective of the input. This makes it possible to operate small plants—working as little as 30 bbl. a day—under the same favorable conditions as large plants.



Diagrammatic arrangement of the new Wilton system

Crude oil is admitted into the distillation column until it reaches a predetermined level. The circulating pump is then started. This withdraws the crude from the distillation column, passes it through the pipe-still where it picks up heat, and then returns it to the distillation column, where it passes over a series of specially constructed weir plates before returning to the base of the column. This cycle is repeated continuously until the desired temperature and quality of the residuum is reached. The distillate vapors from the crude pass from the two sections of the column into the fractionating column and are kept there until the desired temperature and quantity is also obtained.

As soon as the products are up to desired specification crude is admitted. This mingles with the residuum in circulation and immediately gives up the light distillate vapors in an initial flash by absorbing a small portion of the sensible heat available. The introduction of the crude raises the level in the base of the distillation column until it reaches a level where an automatic controller opens a discharge valve on the finished product line and emits a quantity which corresponds to the quantity of crude admitted less the oils removed. No matter what the rate of input, there is always a quantity maintained in the base of the distillation column to allow the circulating pump to create a constant turbulence. No trouble can be experienced through coking or burning out of the pipe-still. The crude, instead of entering the coil, passes into the hot residuum stream and is partly distilled, freeing practically all its corrosive elements, which pass out with the vapors. The crude, which passes several heat exchangers and enters the distillation column at a high temperature, reduces the temperature of the residuum only a few degrees, thus creating only a small temperature difference between input and output of the pipe-still coil. This low temperature difference enables cast iron, which has non-corrosive features, to be used. The intensive furnace heat and high heat transfer rates are correspondingly reduced.

Cost Figures on Solvent Refining—Eugene R. Smoley, A. Henry Schutte and H. R. Davis, in PETROLEUM WORLD, Vol. 35 (1938), No. 11, pp. 59-68; 62; 64.

This paper lists 42 solvent extraction plants for the production of lubricating oils and 38 solvent dewaxing plants in Europe and America. The lube plants have a combined charging capacity of 83,410 bbl. a day and the dewaxing plants 49,850 bbl.

The writers are interested chiefly in the furfural extraction and the benzol-ketone dewaxing processes. Furfural extraction plants have a total capacity of 26,500 bbl. a day or 32 percent of all solvent extraction plants. The benzol-ketone dewaxing plants have a total daily capacity of 31,250 bbl. or 63 percent of the world's solvent dewaxing capacity.

The operating costs of the furfural solvent refining process range from nine to 12c a bbl. on California distillates, depending on type of operation and charging stock. The direct operating costs of benzol-ketone dewaxing is 21c per bbl. of charge oil when running wax distillate and 27c a bbl. for cylinder stocks. Operating costs in the newer plants are smaller, due to the use of improved methods of solvent recovery.

85 Percent Gasoline of 81 Octane from Gas Oil—W. T. Ziegenhain in OIL & GAS JOURNAL, Vol. 37 (1938), No. 30, p. 23.

A catalytic cracking unit of simple design and operating procedure at the Riverside, Ill., research plant of the Universal Oil Products Co. is of semi-commercial capacity but large enough to have served as the basis for the design of several large commercial units which are to be constructed within the next few months. This unit proved to be of unusual interest because of its ability to produce 85 percent gasoline of 81 octane number from Mid-Continent gas oil.

This yield is based upon a recycle operation but the extent of recycling is well within commercial practices on thermal cracking units. This yield also includes that from catalytically polymerizing the cracked gases, 95 percent of which may be polymerized as they leave the catalytic cracking plant.

The 85 percent gasoline fraction contains monoolefins and is stable with respect to color, octane value and is about 10 lb. vapor pressure.

As an alternate operation the unit may be run to produce up to five percent isooctenes on a single-pass basis or 12.5 percent in a recycling operation. The isooctene fraction may be hydrogenated to isooctane gasoline. If the latter is recovered by hydrogenation of isooctenes as a specialty product, the balance of the motor fuel production of about 73 percent by volume will be about 81 octane number.

The catalytic cracking unit may be described as banks of catalyst reactors with automatic controls provided to alternate the flow of heated oil first through one-half of the catalyst reactors and then through the other while the catalyst in the first reactors is being activated.

Revivification is accomplished by burning off the carbon which collects on the catalyst and this in turn simply necessitates passing a predetermined amount of air through the tube and maintaining a moderate temperature of combustion. Twenty types of charging stocks have been investigated for the purpose of selecting the most practicable catalyst and the range of stocks tried has extended from Kettleman Hills, Calif., residuum to Pennsylvania gas oil. Highly paraffinic overhead distillates are favored.

Corrosion Protection of Refinery Equipment—J. A. Jamison, before AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1938.

This paper is the result of a field survey of corrosion problems of refinery equipment in the major refining areas of the United States. The data were secured under the sponsorship of the Institute's Committee on Corrosion of Refinery Equipment,

and through the cooperation and assistance of members of the committee and corrosion contact men in the various refineries.

Because the problem of refinery corrosion is such a broad subject, it has been possible to deal only with the more common types of units such as crude-distillation, viscosity-breaking, cracking, pressure-distillate re-run, gasoline-recovery, and stabilization. Sufficient data are not available on the relatively new operations of solvent-treating, polymerization, and similar specialty plants. The study has been limited to the larger pieces of equipment such as furnace tubes, towers, and tubular exchangers. Practical considerations have made it necessary not to include the important but too numerous smaller items such as piping, valves, pump parts, etc.

Even with this limitation, the 50 case histories and summaries contain a mass of information that is well worth study by refinery engineers.

Propane in Manufacture of Pennsylvania Motor Oils—W. B. McCluer, J. T. Dickinson and H. O. Forrest, in OIL & GAS JOURNAL, Vol. 37 (1938), No. 27, pp. 209-210; 244.

The status of the Pennsylvania refiner as a manufacturer and marketer of lubricating oils has been appreciably changed during the past few years by events which include: competition of improved oils produced from lower cost crudes; reduction in the average viscosity required for automotive oils with a resultant greater surplus of bright stock; and demand for lubricants of still higher quality brought about by the use of more severe engine conditions.

To combat these changed conditions, it appears that the Pennsylvania refiner should make changes in his refining methods which will improve the quality of lubricants produced, increase the quantity of neutral equivalent obtained from the crude, and decrease manufacturing costs.

Commercial operating results have been presented which show that the use of propane processing methods will reduce manufacturing costs, increase the amount of blended motor oils which can be made and correspondingly decrease the surplus bright stock, while at the same time giving an increase in the overall yield of lubricants and some improvement in the quality of the bright stock and serving as a means of preparing residual stocks for most efficient treatment with selective single solvents.

Heat Characteristics of 5 Silicon-Chromium-Molybdenum Steels—A. E. White, C. L. Clark and W. G. Hildorf, in OIL & GAS JOURNAL, Vol. 37 (1938), No. 29 & 30.

The results presented in this experimental study are believed to prove conclusively that acceptable steels for high temperature service can be obtained through the addition of silicon, in amounts up to 1.50 percent, to steels containing varying amounts of chromium and 0.50 percent molybdenum. The resulting steels possess a suitable combination of strength, ductility and impact resistance at room temperature. It is true that, on the basis of 1,000 hr. creep tests under slightly oxidizing conditions, the addition of silicon in this amount lowers the creep strength at certain of the elevated temperatures. Because of the increased surface and structural stability which it imparts it does, however, increase the load-carrying ability at these temperatures as indicated by the stress-rupture results. Increased silicon content does, therefore, increase the actual service life even though it does decrease the creep strength.

The Sicromo steels possess a large degree of high temperature stability, retaining their original properties under the combined influence of time and stress at each of the temperatures considered. Their hot ductility characteristics are likewise good under the influence of time, temperature and stress, thus assuring that brittle type fractures will not be obtained in service.

These steels do therefore provide relatively inexpensive materials for use at temperatures extending up to 1,300 deg. F.

Chemical and Refining Study of Some Wyoming Black Oils—H. M. Thorne and Walter Murphy, in BUREAU OF MINES REPORT OF INVESTIGATIONS No. 3423 (November, 1938); 39 pages.

This investigation was a research to find out what to do with Wyoming crude oils characterized by high sulphur, high asphalt and low gasoline content. The conclusion is that such oils should be reduced to an asphaltic residue, and all or a portion of the distillate cracked to produce motor fuel.

Determination of Yield Per Pass, Time of Treatment, Density and Their Instrumental Control in Commercial Cracking Units—Robert L. Rude, Raymond D. Junkins and Colin Barnes, before AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1938.

The time of treatment in cracking is determined from measurements of density *in situ* of the fluid in the conversion section. The density is determined from the known weight rate of furnace charge and the differential head developed at adjustable orifices installed in the path of flow. Tests conducted on commercial cracking units have provided data permitting the empirical correlation of time, temperature, stock characteristics, and yield per pass. On the basis of this correlation, instruments have been developed for the continuous control of the cracking operation. The tests showed further that the density at the outlet of the conversion section is an index of the total heat in the synthetic crude, and that this heat can be varied over wide limits while maintaining a desired yield per pass.

The term *in situ* is used in this paper to distinguish the directly-determined density of the fluid in its flowing condition from the density obtained by any indirect means such as sampling.

The construction of the instruments and their uses are fully described with the aid of photographs and diagrams, and the theories of their operation fully explained.

CHEMISTRY

Oxidation Experiments on Roumanian Lubricating Oils—C. Candea and C. Manughevici, in MOTORENBETRIEBE UND MASCHINEN-SCHMIERUNG. Vol. 11 (1938), No. 12, pp. 4-6; PETROLEUM Vol. 34 (1938), No. 49.

Oxidation experiments were made by heating the lubricating oil in contact with air for two hours at temperatures of 100 deg., 200 deg., and 300 deg. C., with and without an anti-oxidant, which in all cases was thymol. As little as 0.02 percent of the anti-oxidant was sufficient to cause a perceptible reduction in the acid number and the amount of peroxide formed in comparison with the untreated oil. A temperature of 200 deg. is most favorable for peroxide formation, while at this temperature the saponification number is at a minimum.

In a second experimental series the influence of the amount of the anti-oxidant on the oxidizability of the oil was studied at given temperatures. It turned out that at 200 deg. C. the maximum anti-oxidizing effect was attained with 0.4 percent of thymol; at 300 deg. C. the best action was with 0.2 percent of the anti-oxidant.

Splitting of Lamp Oil by Catalysis—C. Otin and S. Savencu, in PETROLEUM, Vol. 34 (1938), Nos. 46 and 47.

In the recent literature on cracking the view is steadily gaining ground that in the splitting of hydrocarbons it is the temperature that plays the chief role, whereas the pressure and the time of heating are of minor importance.

From their investigations on splitting lamp oil the authors reach the same conclusion. They heated lamp oil (sp. gr. 0.8012; 89 percent at 250 deg. C.) for 10 hr. at 10 and at 20 atmospheres, which produced only trifling changes in the physical-chemical constants of the oil.

The situation is immediately altered in the presence of substances that function as positive catalysts. Heating at 20 kg. per sq. cm. with magnesium chloride produced a yield of 2.5 percent of gasoline. Ferric chloride is somewhat better, giving a gasoline yield of five percent. Aluminum chloride is the best catalyst in this reaction, producing a gasoline yield of 31 percent. Under certain circumstances time is also a factor when catalysts are used; heating for six hours with Al Cl_3 at ordinary pressure gives 41 percent, at 20 at. pressure 55 percent of gasoline.

PHYSICS

Determination of the Aniline Point of Dark Petroleum Products—W. R. van Wijk and J. W. M. Boelhouwer, in JOURNAL INSTITUTION PETROLEUM TECHNOLOGISTS, Vol. 24 (1938), No. 181, pp. 598-604.

The aniline point of an oil, or the temperature at which a 50/50 solution of the oil in aniline begins to demix, can easily be observed with light-colored products; in opaque oils the aniline point is determined by measuring the viscosity of the 50/50 mixture at different temperatures from well above to well below the demixing point and observing where the viscosity curve breaks.

The authors have worked out in detail a method in which the aniline point of dark oils is recognized by measuring the transparency of such oils to infra-red radiation as a function of the temperature, as follows:

The oil is mixed with the aniline at a temperature well above the expected demixing point. The mixture is poured into a test jar surrounded by a cooling liquid and the whole is placed between an incandescent lamp and a thermopile. As the oil is cooled down the temperature is read at 1 deg. C. intervals and the deflection of a galvanometer connected to the thermopile is noted and plotted as a function of the temperature. A sharp break in the curve occurs at the temperature at which the aniline begins to separate. A number of oil samples can be mounted in the apparatus and successively interposed between the lamp and the thermopile.

The method is convenient, the reproducibility is good and the results satisfactory.

Ultraviolet Absorption as a Basis for a New Method of Estimating Aromatics in Fuels and Lubricants—F. Jostes, in OEL UND KOHLE, Vol. 14 (1938), No. 46, pp. 1012-1033.

Present methods of analyzing petroleum products depend largely on the different reactivities of olefines, aromatics, paraffins and naphthenes with sulphuric acid. Since these reactions are far from sharply limited, they are far from exact.

The present article deals with the problem of differentiating the aromatic constituents by means of their absorption of ultraviolet light, which does not involve any chemical attack on the molecules. The method depends on a determination of the

median extinction coefficients for wave lengths between 2,600 and 2,700 Angstrom units. By applying the method to a gasoline and its distillation fractions, and taking into consideration the average molecular weights and specific weights, the aromatic contents may be figured out with a probable accuracy of about five percent.

Theoretically, the method can be applied to heavier oils, but here the complexity of composition creates difficulties which must be solved by future work.

ASPHALT AND TAR

Asphalt and Related Bitumens in 1937—S. H. Redfield, in MINERALS YEARBOOK, 1938, pp. 977-988.

The indicated domestic demand for petroleum asphalt was two percent larger in 1937 than in 1936. For the first seven months of 1937 the tonnage apparently demanded was 15 percent larger than in the corresponding months of 1936. After a decline in August and a rally in September, the last quarter of 1937 closed with an indicated demand 15 percent less than in the corresponding quarter of 1936. In terms of the long-time trend from 1908 to 1936 the decline was slight—from 18 percent above trend in 1936 to 17 percent above trend in 1937. Depending for the major part on Government policies of highway construction—Federal, State, and local—asphalt demand was less affected than demand for other commodities by the industrial recession during the latter part of 1937. Rock-asphalt sales did not profit equally by the steady demand for high-type paving; they were 18 percent less in tonnage in 1937 than in 1936.

A small increase in building construction, especially residential, in 1937 over 1936 was evidenced by a slight gain in sales of roofing asphalt and flux from 1936 to 1937. Sales of waterproofing asphalt and flux used in building construction, however, were lower in 1937 than in 1936.

Petroleum refineries produced seven percent more asphalt in 1937 than in 1936. The total refinery output in 1937 included 177,936 tons of other petroleum products blended with the asphalt to produce commercial varieties of the required consistency.

Of the 1937 production of petroleum asphalt, 36 percent was made from foreign crude imported chiefly from Venezuela and Mexico compared with 43 percent manufactured from foreign crude in 1936. Runs to stills of imported petroleum decreased 23 percent—from 33,933,000 bbl. in 1936 to 25,996,000 in 1937. As the recovery of asphalt from imported crude increased from 28 percent of total runs in 1936 to 33 percent in 1937, the production of asphalt from imported oil decreased only 10.5 percent—from 1,738,255 tons in 1936 to 1,555,803 in 1937. Of the asphalt manufactured in East Coast refineries in 1937 81 percent, and 30 percent of that manufactured in Gulf Coast refineries, was made from imported crude.

Increased construction of light types of highway, especially for county and farm-to-market roads, resulted in an increase of six percent in sales of road oil by petroleum refineries in the United States—from 8,256,694 bbl. in 1936 to 8,733,650 in 1937. If sales of road oil are considered with sales of cut-back asphalts, paving flux, and emulsified asphalts, there was a smaller proportionate increase (three percent) in total sales of liquid and semiliquid asphalts for highway construction—from 16,427,254 bbl. (revised figure) in 1936 to 16,968,641 in 1937.

The Bitumen Industry, 1937—Walter Schmidt in PETROLEUM, Vol. 34 (1938), No. 44, pp. 13-15.

Available statistics for the 1937 production of refinery and natural asphalt are given in tons in the table below.

	PRODUCTION 1929-33	1934	1936	1937	CONSUMPTION 1937
United States* a)	1,200,000	1,311,000	1,976,000	3,931,000	No Data
b)	1,515,000	1,266,000	1,479,000		
c)	787,000	869,000	1,086,000	1,295,000	No Data
d)	3,582,000	3,460,000	4,542,000	5,227,000	5,037,000
Mexico	179,000	293,000	369,000	472,000	47,000
Canada	121,000	118,000	154,000	291,000	300,000
Argentina	8,000	9,000	27,000	27,000	27,000
Other America	7,000	17,000	21,000	24,000	57,000
All America	3,897,000	3,898,000	5,113,000	6,040,000	5,462,000
Germany	265,000	336,000	589,000	643,000	590,000
Great Britain	418,000	502,000	561,000	577,000	636,000
France	98,000	252,000	308,000	336,000	314,000
Russia	63,000	255,000	238,000	241,000	231,000
Italy	10,000	12,000	46,000	81,000	56,000
Roumania	33,000	84,000	82,000	57,000	35,000
Denmark		48,000	54,000	54,000	91,000
Netherlands (expt.)	86,000	52,000	42,000	37,000	16,000
Belgium		20,000	31,000	35,000	33,000
Poland	20,000	23,000	23,000	26,000	26,000
Sweden	16,000	20,000	19,000	22,000	50,000
Albania (expt.)	5,000	7,000	7,000	10,000	
Other Europe		1,000	3,000	1,000	245,000
All Europe	1,015,000	1,611,000	1,953,000	2,120,000	2,321,000
Japan	25,000	57,000	76,000	79,000	75,000
Iraq	2,000	31,000	31,000	44,000	1,000
Dutch Indies	8,000	9,000	10,000	11,000	28,000
Other Asia					158,000
All Asia	35,000	97,000	117,000	133,000	162,000
Egypt	54,000	59,000	86,000	100,000	10,000
Other Africa					143,000
All Africa	54,000	59,000	86,000	100,000	153,000
Oceania					137,000
Total	5,001,000	5,665,000	7,268,000	8,394,000	8,335,000
Natural asphalt	818,000	672,000	917,000	1,118,000	1,120,000
Rock asphalt	208,000	126,000	150,000	182,000	182,000
Crude asphalt	1,026,000	798,000	1,067,000	1,300,000	1,302,000
Total asphalt content	203,000	139,000	179,000	212,000	212,000
Grand Total	505,000	5,804,000	7,447,000	8,606,000	8,547,000

*In the case of the United States (a) is from domestic petroleum, (b) from imported oil, (c) is road oil, (d) the total.

The proportion of natural asphalt in the world trade has continued to decline until it is now little more than two percent. In the United States only Kentucky and Texas are actively producing; the small production in Italy, France, Germany and Russia is consumed locally. Trinidad is still the only exporting country, whence the natural asphalt goes almost exclusively to the United States and England.

Affinity of Hydrophilic Aggregate for Asphaltic Bitumen—Hans F. Winterkorn, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 30 (1938), No. 12, pp. 1362-1368.

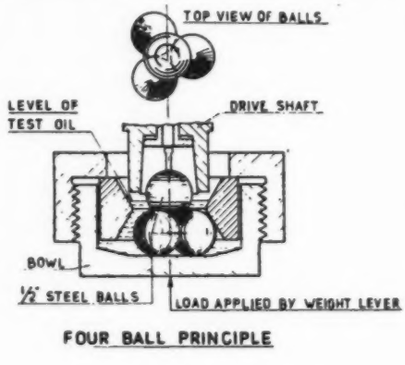
The problem of the affinity of mineral aggregate for bituminous coatings is foremost in the mind of many highway engineers. Although numerous road failures, which have been blamed on improper adhesion, were actually caused by insufficient base support or by faulty design of the bituminous mix, a distinct field exists in which adhesion is of primary importance in bituminous road construction. This field includes the surface stripping, scaling, and pitting of relatively dense bituminous pavements; the stripping from the bottom up of porous oil mats; and the stripping of the bitumen in open-type pavements, which causes loss of the cohesion part of the stability of the pavement. A special nuisance and a source of embarrassment is the stripping of coated aggregate between the time of mixing and that of total compaction on the road. The mix is most vulnerable, and financial and time loss is most apt to occur at this time. An attempt is made to point out the factors which are of greatest importance in the adhesion problem and to propose a cure for at least some of the ills caused by improper affinity of the aggregate for the bitumen.

After enumerating the factors that have to be considered, experiments are described which indicate that the inconveniences described may be mitigated if not cured by precoating or priming the aggregates with some agent that will make the bitumen more adhesive, or, in the technical phrase, to change the surface properties of aggregates from hydrophilic to hydrophobic. The experiments demonstrated that stripping resistance can be remarkably increased by thin coatings of mixtures of furfural and its resinous derivitives. Furfural-aniline mixtures are recommended, and the cost may be made nearly nominal if suitable mixing methods are employed. Soil can also be stabilized by incorporating it with a mixture of furfural, aniline and a slow curing road oil.

USE

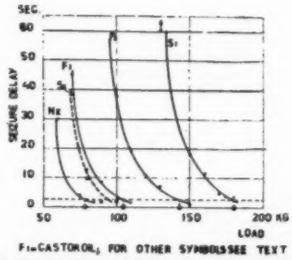
Seizure Delay Method for Measuring Protection Against Seizure Afforded by Extreme Pressure Lubricants—H. Blok, before SOCIETY AUTOMOTIVE ENGINEERS, Tulsa meeting, October, 1938.

The introduction of hypoid gears has made necessary the invention of new types of lubricants, the so-called extreme pressure lubricants (E.P.L.) Since failure of these lubricants to keep the moving metal surfaces apart—allowing them to seize one another—it is of first rate importance to have a method of estimating the degree of protection against seizure afforded by the lubricant. There are two machines now used in making these tests, the S.A.E. machine and the Timken machine. The author (a Royal Dutch-Shell engineer in the Delft laboratory) describes a Four Ball Apparatus which is considered to avoid the errors of other machines.



FOUR BALL PRINCIPLE

The Four Ball Apparatus for testing E.P.L. was invented by the late G. D. Boerlage. The four-ball principle eliminates the wedging action of the lubricant and hence the effect of its viscosity. As shown in the left hand figure of the accompanying illustration the apparatus consists of three balls clamped together immovably in a bowl and immersed in the oil or grease to be tested. A fourth ball is clamped automatically in a chuck fixed in the lower end of a shaft driven by a 1½ h.p. electric motor which attains 1,450-1,500 r.p.m. within a few tenths of a second; this top ball is situated vertically above the center of the triangle formed by the three underlying balls. For each test at a constant load a new set of ½ in. S.K.F. hardened chrome steel ball bearings are used. A load of 10 to 800 kg. may be applied by means of a lever which pushes the bowl upwards. The pressure is equivalent to 100 to 400 tons per sq. in.



F=CASTOROIL; FOR OTHER SYMBOLS SEE TEXT

SEIZURE DELAY CURVES ON FOUR BALL APPARATUS (500 rpm) FOR DIFFERENT LUBRICANTS

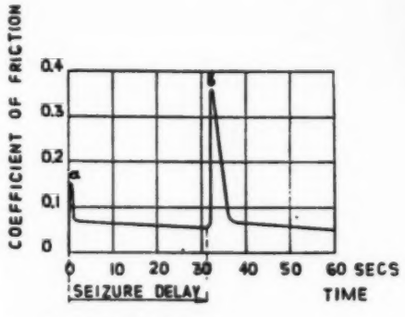
The test has the following features: At relatively low loads no seizure will occur, the friction coefficient remaining practically constant. At higher loads seizure may occur within one minute with an intensity and at a load that are dependent on the properties of the lubricant; generally seizure occurs only once during a test but may be repeated. It is invariably found that the time elapsed from the start of the test up to incipient seizure—the so-called seizure delay—decreases with increasing loads and shows a sharp peak, as in the middle diagram of the illustration. When a series of tests are made with different E.P.L. their seizure delay curves may be plotted, as in the right hand diagram, thus characterizing the various lubricants. In this diagram the symbols refer to lubricants belonging to the following groups:

N: non-doped mineral oils.

S: lubricants containing sulphur and sometimes lead and/or chlorine.

F: castor oil.

P: lubricants containing phosphorus.



a = SWITCHING-ON PEAK

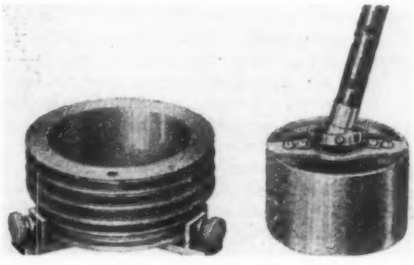
b = SEIZURE PEAK

FRICTION DIAGRAM; SEIZURE

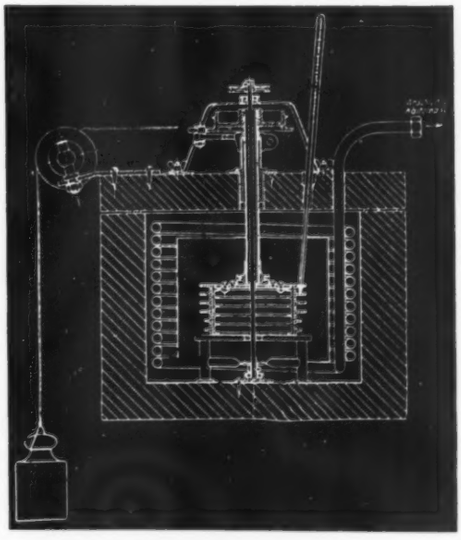
E.P.L. lubricants that are more powerful than current hypoid greases can also be rated in this machine. The reproducibility is very satisfactory and only a small quantity of the lubricant is required for a complete series of tests (100 cc. in most cases).

Measuring Oil Viscosity at Below Freezing Temperature—Karl Schwaiger in PETROLEUM, Vol. 34 (1938), No. 45, pp. 1-6.

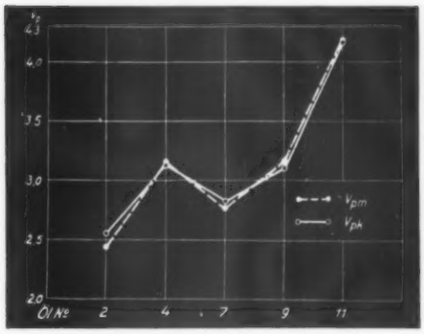
It is required of an automobile engine that it shall start easily in cold weather, and since ease of starting depends in large measure on the viscosity of the motor oil the viscosity of these oils at low temperature becomes of much interest. The ordinary viscometers are of little or no use for this work, particularly if the oil has a relatively high cold point.



The author describes a viscometer that operates on the rotation principle at any temperature. The constructive details are shown in the accompanying illustration. It consists essentially of two cylinders, one of which fits within the other with a clearance of 0.05 millimeter, which is about the clearance between



piston and cylinder in an automobile engine. The space between the cylinders is wet by the oil to be tested. In making a test the fitted cylinders are placed in an insulated chamber which is provided with a cooling coil and a pulley for rotating the inner cylinder while the outer one remains fixed. When the oil in the chamber is cooled to the desired temperature, the inner cylinder is rotated by releasing a weight attached to a cord passing over the pulley, and the time required for the weight to pass through a fixed distance is measured; this time is a function of the dynamic viscosity of the oil at that temperature.



After establishing the dynamic viscosities of a number of oils, the electric energy consumption of an automobile engine lubricated by the same oils at the test temperatures was investigated. The results showed that the curves of viscosity as determined by the motor (V_{pm}, see diagram) and as determined by the cold viscometer, V_{pk}, practically coincide. This proves experimentally that the starting resistance of a cold motor is directly proportional to the viscosity, which heretofore was suspected but not proven. It was also proven that the difference between starting resistance and running resistance is proportionally the same at all temperatures, which means that stickiness of an oil is not specially related to low temperature.

Anti-Knock and Mixture-Distribution Problems in the Multi-Cylinder Engine—A. J. Blackwood, O. G. Lewis and C. B. Bass, before AMERICAN PETROLEUM INSTITUTE, Chicago meeting, November, 1938.

The annual surveys of car octane-number requirements which the institute has sponsored for the past few years has invariably disclosed the fact that even a single model of any one make of car cannot be said to have a definite octane-number requirement. It is not unheard of to find 10 cars of a given make and model—all in apparently the same condition as regards mileage, cleanliness, and mechanical condition, and all adjusted in exact accordance with the manufacturer's instructions—differing from one to the other by 10 or even 15 octane numbers.

In an effort to discover why cars in apparently identical condition and adjustment should differ so widely in their anti-knock requirements, this work was initiated. It has long been known that air-fuel ratio has a profound effect on detonation, and one of the first steps in making the multi-cylinder-engine study was a careful analysis of the mixture distribution to the individual cylinders and later tying these results with the detonation experiments. The tests subsequently were expanded to include the effect of certain fuel characteristics on variation knock.

From this work some rather broad generalizations seem justified. The wide differences found in the octane-number requirements of individual cylinders, plus the failure to obtain uniform mixture distribution from cylinder to cylinder without resorting to fuels of aviation-grade volatility, make it appear that present-day cars are not capitalizing on the continued efforts of the petroleum industry to provide fuels of better volatility and higher octane numbers. Precautionary measures might be included in the assembly of the engine at the factory to insure that the cylinders normally receiving fuel mixtures most likely to detonate do not receive simultaneously the greatest spark advance. This should result in a decrease of several points in octane-number requirement which, in turn, could be utilized to permit of higher compression ratio.

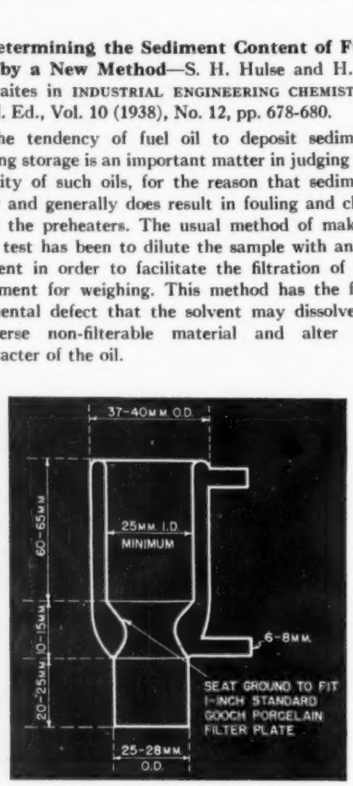
New Use for Butanol (The Butanol Cooking Process)—John M. McMillen and Others, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 30 (1938), No. 12, pp. 1407-1409.

Normal butanone, or butyl alcohol, can be used to pulp satisfactorily any kind of hard wood (birch, aspen), but cannot be used with the same success in pulping soft woods (spruce, pine).

This is interesting for several reasons. Butyl alcohol is one of the organic chemicals synthesized from petroleum gases, and could possibly be supplied in large quantity. At present only soft woods are used in making paper pulp and cellulose, because they are easily delignified by means of calcium bisulphite liquor, which has little or no effect on the lignin of the hardwoods. The successful depulping of hardwoods by butyl alcohol would not only widen the outlet for a petroleum product but would also open up a vast new source of raw material for the paper and pulp industries.

Determining the Sediment Content of Fuel Oil by a New Method—S. H. Hulse and H. L. Thwaites in INDUSTRIAL ENGINEERING CHEMISTRY. Anal. Ed., Vol. 10 (1938), No. 12, pp. 678-680.

The tendency of fuel oil to deposit sediment during storage is an important matter in judging the quality of such oils, for the reason that sediment may and generally does result in fouling and clogging the preheaters. The usual method of making this test has been to dilute the sample with an oil solvent in order to facilitate the filtration of the sediment for weighing. This method has the fundamental defect that the solvent may dissolve or disperse non-filterable material and alter the character of the oil.



The new method developed by the inspection department of the Standard Development Company involves filtering the undiluted heated oil through an asbestos mat in a steam jacketed filter (see drawing) and washing the sediment with a high-flash paraffinic naphtha, drying and weighing.

Petroleum Oils for Anti-Malarial Measures—D. R. P. Murray, in PETROLEUM TIMES, Vol. 39 (XI), No. 1039 (1938), p. 763.

The value of an oil for killing mosquito larvae depends largely on its ability to spread evenly over the surface of water, in other words its spreading pressure. It has been found that certain substances when added to an oil increase its ability to spread out in a thin film; such substances are formed when oil is exposed to light and may be extracted with methyl alcohol. It is better to use certain petroleum sulphonic acids, or what is known as cracked spirit gum, which settles out of gasoline having a high content of olefines. Oils containing such materials spread widely and make permanent thin films.

A New Method of Determining the Ignition Point of Powdered Fuels—Fritz Jostes and Konrad Siebert, in OEL UND KOHLE, Vol. 14 (1938), No. 45, pp. 919-931.

The authors describe a new apparatus for measuring the ignition temperature of solid fuels for Diesel engines which avoids the faults of previous methods (Jentzsch, Wentzel). It consists essentially of two pressure vessels one above the other and connected by a tube in which is a manually operated spring valve. The fuel to be tested is placed in the upper vessel, and is blown into the lower one which is filled with oxygen or air that has been electrically heated to a certain temperature.

The principal of the measurement is based on the thermal reactions in the ignition chamber. The heat of combustion causes a brief increase of both temperature and pressure, the highest value of which decreases with the original temperature of the bomb and becomes nil at the ignition point. When ignition experiments are made with lower and lower bomb temperatures, each time observing the pressure by means of a manometer, a curve of decreasing temperatures is obtained which intersects a straight line representing the pressure; this point of intersection gives the ignition point of the fuel.

Mixed Diesel Fuels with Coal Tar Oil—Herbert Kolbel, in OEL UND KOHLE, Vol. 14 (1938), No. 46, pp. 1042-1049.

Heretofore coal tar oil with a cetene number of about 20 could find use as a Diesel fuel only in slow engines and then only after mixing with a considerable proportion of a high grade mineral oil. The present research shows that a most excellent Diesel fuel can be made by mixing equal proportions of ordinary coal tar oil with the product known as Kogasin II, which is a product obtained in the Fischer-Tropsch synthesis of petroleum from water gas (boiling point above 200 deg. C.). Such a mixture is distinguished above all Diesel fuels on the German market by its easy ignition, quick starting, rapid pick-up under load and suitability for high speed engines. A special characteristic of this fuel, proven by many analyses of exhaust gas, is the low content of carbon monoxide in the exhaust.

Considerations on the Engine Evaluation of Diesel Fuels—A. W. Schmidt and F. Kneule, in OEL UND KOHLE, vol. 14 (1938), No. 46, pp. 1034-1039.

There are three groups of methods in use for determining the ignition qualities of Diesel fuels.

1—The reciprocal octane method, which is based on the assumption that the ignitability of a fuel is approximately proportional to its anti-knock value; this test is made in a C.F.R. motor by determining the octane number of a mixture of 20 percent of the Diesel fuel with 80 percent of a gasoline of known octane number.

2—The starting method, by which is determined the compression ratio at which the injected oil will ignite.

3—The ignition delay method, which measures the delay in ignition under the usual operating condition.

According to the present research the ignition delay method appears to be the best on account of its easier control and good reproducibility. It is equally applicable to routine operating control and for the scientific guidance of engine builders and fuel manufacturers.

Next in importance to ignition delay is the tendency of the Diesel fuel to coke in the engine. The best test of this character appears to be the Conradson test.

RESERVES

What Life Has the Oil Age?—A. T. Shurick, in OIL WEEKLY, Vol. 91 (1938), No. 25, pp. 64; 66; 67; 72; 76; 78; 80; 82.

Using a new mathematical principle derived from experience in prognostigating progressive steps in the exhaustion of certain known mineral reserves, and making certain assumptions as to the perfectibility of geophysical methods of finding new oil-bearing formations, the author calculates that oil production will reach a peak in 1943, with reserves amounting to double the present reserves (estimated by the A.P.I. at about 15½ billion bbl.). In 1946 these reserves will be tripled and in 1951 quadrupled. While admittedly some of the assumptions are hypothetical, it is claimed that the method of calculation is mathematically precise, and the conclusions reached are more or less well supported.

Reserves of New Illinois Fields—Grady Triplett, in OIL WEEKLY, Vol. 91 (1938), No. 25, pp. 47-50; 52.

Known new fields of the Illinois Basin are estimated at this stage of their development to have 302,590,000 bbl. of recoverable reserves. This figure is based on the estimate that an ultimate recovery of 318,054,000 bbl. has been discovered, of which 15,464,000 bbl. have been produced already.

When this total is considered in relation to the total reserves of the United States it seems trivial. But several factors make it exceedingly important. In the first place it is a tremendous increase over the 28,000,000 bbl. estimated by the A.P.I. as the reserve of the entire state on January 1st, 1937, having brought the total reserve for the state to a level in excess of 325,000,000 bbl. at this time. When considered in relation to its market desirability it is vital, despite any appearances of smallness. Being where it is in relation to consumption, it allows Illinois reserves to hold a whip hand more threatening than any amount of oil less than a 500,000,000 bbl. would command otherwise.

Acreage already proven in Illinois is 36,350. Recovery therefore is calculated at 8,750 bbl. per acre for both lime producing fields as well as sand producing fields. The fact that this recovery figure is well above the total so frequently used for Illinois prompts this explanation—the Loudon field, largest in the area is producing from two sands, thus the 18,000 acres for this field covers two producing sands. Without this situation per acre recovery for Illinois would drop to 5,000 to 6,000 bbl.

ECONOMICS

What Does It Cost to Discover Oil?—Brad Mills, in OIL WEEKLY, Vol. 91 (1928), No. 12, pp. 19-22.

Theoretically, the cost of finding oil during any one year is the amount of money spent in exploratory effort, divided by the number of barrels of oil discovered.

However, yearly expenses and discoveries do not represent the general average cost when costs and results are averaged over a period of years; the average cost also depends on the size and richness of

the district considered. In a small district where a large number of wells have yielded little new oil the discovery cost is naturally high. When one or two shallow wells open up an enormous pool the discovery cost of the oil will appear extremely low; such was the case with the discovery of the East Texas field, where billions of barrels of oil were opened to development at a cost of 1/2000 of a cent per bbl. On the other hand, many operators have spent large sums without discovering any oil at all.

Taking averages of the United States as a whole during the past 15 years the discovery cost has been about 20c a barrel for reserves. Taking the last five years and limiting the calculations to the operation of several companies working with geophysical prospecting methods, the discovery cost is less than 15c a barrel.

During the past few years discovery costs in Oklahoma have probably exceeded 20c. In California costs have shown a wide range, but is probably around 20c. West Texas costs range from 15 to 35c, but the average does not exceed 25c. Discovery rates have been high in South and Southwest Texas and although reliable figures are difficult to obtain it is doubtful if discovery costs in these districts exceed 15c a barrel. Average discovery costs in Kansas during the past five years are put at 15c. In the Rocky Mountain region the costs in various districts has been tremendous, but owing to the huge reserves found in the Salt Creek district the average for the region has been brought down to not more than 20c. One of the most successful Gulf Coast companies has placed its discovery costs at less than 10c a barrel. Arkansas costs are put at about 15c over a period of 18 years, which also appears to hold for Illinois and Michigan.

From all this it appears that while discovery costs by different operators and in different districts have been extremely variable, an average of 20c, for the whole country is reasonable, and it is concluded that when it is necessary for a company to spend more than 20c a barrel for finding oil the outright purchase of leases may be the better plan.

GENERAL

Analysis of Petroleum from Schuler Field, Arkansas—BUREAU OF MINES BULLETIN, November 22, 1938.

Samples of crude oil from the Schuler field have been collected and analyzed by the Bureau of Mines. Two that are typical of the oil being produced, respectively, from the Morgan zone and the two lower horizons are presented. A sample obtained from Morgan D sand has a gravity of 41.9 deg. A.P.I., a sulphur content of 0.54 percent. a carbon residue of 2.3 percent, and is a paraffin base oil, whereas a sample from the Jones sand has a gravity of 32.1 deg. A.P.I., a sulphur content of 1.55 percent, a carbon residue of 3.8 percent and is intermediate in base. This is one of the rare cases where a paraffin base crude oil is produced from an upper horizon in relation to naphthene base oils from lower horizons.

The Typical Motorist—Annual Report of Board of Directors of AMERICAN PETROLEUM INSTITUTE, 1938.

The typical motorist is 43 years old, the father of two children, a boy and a girl. He earns $20 to $30 a week, and the chances are two to one he has never owned a new car. His present car worth $238, is between four and five years old. He drives 8,500 mi. a year, mostly within 100 mi. of home, and uses slightly more than 600 gal. of gasoline, 35 qt. of lubricating oil, and $25 worth of tires, tubes, parts, and accessories. The time he devotes to driving each year represents 40 full eight-hour working days.

On the annual operation of his car he pays $53:

State gasoline taxes	$25.48
State registration and license fees	13.45
Federal gasoline taxes	6.83
Other federal automotive taxes	4.54
Local automotive taxes	2.70
1937 Total Taxes Paid Per Vehicle	$53.00

His special motor taxes average 17c for every hour of driving. Contrary to the popular belief, this money is not all used on the roads and the highways. One out of every seven dollars is spent ultimately for other than highway purposes, according to the U.S. Bureau of Public Roads.

The motorist pays the same general taxes as the non-motorist, and some $10 additional. Thus, actually he pays twice for the general support of the government: once in regular general taxes, and again in the motor taxes not used on roads.

Suitability of Several Casing Steels for Field Welding—L. R. Hodell, before AMERICAN PETROLEUM INSTITUTE, Chicago Meeting, November, 1938.

Approximately 200 joints of casing representing 6 different steels have been welded under field conditions, and quenched at varying time intervals after breaking of arc. Results indicate that the various steels respond differently to the quenching. As a result of comparing manners in which they respond with the exigencies of field practices, certain of these steels are considered weldable and certain others are not weldable when used in the field welding of casing. In order to establish a standard, a test procedure has been proposed for the purpose of determining the field weldability of various casing steels.

The proposed tests are considered too elaborate for routine acceptance tests; they are of use mainly to manufacturers of new types of casing steels, and provide a basis on which the manufacturers and the buyers may understand one another when discussing the weldability and non-weldability of steels.

Main Currents of Petroleum Transport—REVIEW PETROLIFERE, No. 818 (1938), p. 1703.

A compilation is given of figures of petroleum movements during the months of July, August, and September, 1938, gathered from 104 ports of shipment and 434 ports of entry, as in the table below.

Among the exporting countries Venezuela is in the lead, followed closely by the United States. The chief importing countries are Great Britain, France, Canada, the United States, Japan, Germany, and Italy.

PETROLEUM EXPORTING COUNTRIES

	July	August	Sept.	Totals
Venezuela	1,816,000	1,921,200	1,677,300	5,414,500
United States	1,684,400	1,741,700	1,417,260	4,843,360
Iran	480,700	629,700	558,150	1,668,550
Dutch Indies	366,900	251,200	286,400	904,500
Iraq	350,200	307,100	239,650	896,850
Roumania	220,700	180,200	160,450	561,350
Mexico	89,500	158,000	98,800	346,300
Colombia	48,000	142,800	142,400	333,200
Trinidad	118,200	121,000	90,800	330,000
Peru	43,000	63,800	111,700	218,500
U.S.S.R.	78,800	49,800	36,000	164,600
Bahrein	42,700	48,700	49,700	141,100
Ecuador	14,000	20,500	9,000	29,500
Africa (Suez)	.....	24,800	.....	24,800
Totals	5,353,100	5,660,400	4,877,610	15,877,110

PETROLEUM IMPORTING COUNTRIES

Great Britain	1,094,460	848,500	845,550	2,788,510
France	576,300	551,000	538,650	1,665,950
Canada	480,800	381,600	448,550	1,310,950
United States	442,200	381,900	401,200	1,225,300
Japan	415,250	303,650	296,700	1,015,600
Germany	360,200	282,100	358,850	1,001,150
Italy	335,950	335,600	273,350	944,900
Holland	293,250	332,800	304,200	930,250
Africa	307,900	235,850	335,150	878,900
India	268,400	217,800	266,200	752,400
Argentina	136,800	107,500	212,250	456,550
Australia	108,200	98,250	99,000	305,450
Sweden	98,550	98,300	89,400	286,250
Belgium	62,950	136,400	81,300	280,650
Brazil	90,000	92,500	95,250	277,750
Norway	43,400	64,050	63,650	171,100
Portugal	46,000	40,900	65,900	152,800
Egypt	36,800	55,050	59,800	151,650
Spain	60,000	30,900	60,550	151,450
Denmark	57,500	31,750	52,350	141,600
Chile	22,200	43,500	72,300	138,000
China	31,200	72,800	32,800	136,800
West Indies	29,750	31,100	72,800	133,650
Uruguay	39,500	38,000	34,700	112,200
New Zealand	41,500	48,500	29,800	119,800
Finland	41,500	27,750	14,350	83,600
Teneriffe	12,000	53,000	18,500	83,500
Panama	25,000	25,200	8,500	59,700
U.S.S.R.	.....	17,300	29,500	46,800
Greece	21,000	22,300	.....	43,300
Turkey	9,000	7,000	24,300	40,300
Indo China	24,100	1,350	10,700	36,150
Bermuda	.....	.....	25,250	25,250
Syria	15,600	5,000	.....	20,600
Lithuania	11,900	6,000	.....	17,900
Latvia	9,700	6,000	.....	15,700
Malta	.....	3,250	7,250	10,500
Philippines	.....	.....	6,000	6,000
Totals	5,648,860	5,034,450	5,334,600	15,917,910

WORLD OIL P

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified

U. S. BARRELS

	March 1938	April 1938	May 1938	June 1938	July 1938	August 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Preliminary Figures Feb. 1939
United States	106,524,000	102,702,000	98,674,000	94,277,000	102,898,000	106,165,000	98,661,000	101,830,000	98,567,000	102,287,000	102,490,000	93,475,000
Soviet Union[4]	15,984,000	17,850,000	17,580,000	18,540,000	18,200,000	17,600,000	17,500,000	17,400,000	17,250,000	17,050,000	17,000,000	17,500,000
Venezuela	15,109,040	13,696,219	15,994,400	16,302,150	14,912,555	16,616,673	16,271,096	17,352,171	16,356,204	16,744,163	16,489,347	14,899,459
Iran[5]	8,284,215	7,090,486	6,975,256	5,792,228	5,338,990	5,861,366	5,676,998	7,136,578	7,221,080	6,624,726	7,100,000[1]	6,400,000
Netherland India: Sumatra	2,912,764	2,809,415	2,971,443	2,893,856	2,814,237	2,901,321	2,917,167	3,049,196	3,015,432	3,177,589	3,129,007	2,969,950
Borneo	1,114,431	1,056,224	1,066,281	1,013,163	1,061,980	970,690	1,069,872	1,123,102	1,090,009	1,114,535	1,115,570	1,000,937
Java[9]	643,568	639,582	674,927	616,845	585,086	524,384	482,417	523,623	515,160	529,658	535,297	503,441
Ceram	50,377	53,670	51,524	49,870	54,035	54,825	50,355	50,444	45,750	45,773	49,200	55,219
Roumania	4,182,000	4,090,000	4,169,000	4,015,000	4,115,000	4,075,736	3,915,029	4,028,750	3,847,324	3,969,300	3,934,338	3,638,020
Mexico	3,981,985	2,129,127	2,484,814	2,564,886	2,864,277	3,247,904	3,416,583	3,313,182	3,098,725	3,245,558	2,470,000[1]	1,960,000
Iraq	2,717,278	2,592,996	2,332,746	2,653,579	2,806,903	2,829,528	2,621,547	2,431,949	2,420,143	2,290,777	2,414,878	1,955,122
Colombia	1,841,882	1,642,195	1,819,689	1,826,136	1,826,848	1,870,013	1,797,158	1,891,825	1,863,838	1,908,879	1,710,565	1,609,000
Trinidad	1,438,436	1,418,825	1,481,285	1,431,476	1,500,171	1,505,959	1,514,893	1,594,480	1,503,489	1,664,322	1,652,412	1,499,197
Argentina[1]	1,380,000	1,349,000	1,382,000	1,346,000	1,349,000	1,360,000	1,358,000	1,360,000	1,358,000	2,028,000	2,000,000	1,300,000
Peru[3]	1,474,364	1,296,090	1,343,259	1,303,536	1,335,623	1,398,143	1,280,691	1,331,111	1,303,990	1,321,883	1,251,162	1,103,878
Bahrein[6]	737,164	692,403	620,746	661,602	699,176	713,149	714,349	708,962	613,281	623,907	647,988	610,766
Burma[7]	633,644	635,903	667,346	679,368	654,108	637,880	623,630	635,000[1]	650,000[1]	635,000[1]	650,000[1]	500,000
Canada[3]	480,803	464,316	566,086	537,654	693,332	817,706	886,111	685,088	445,514	489,303	531,564	356,218
Brunei[8]	445,194	428,829	445,505	425,184	453,393	448,219	478,080	477,459	484,207	510,500	506,467	453,571
Great Germany: Old Reich[14]	355,684	342,387	329,688	326,842	346,435	342,484	328,098	331,792	307,433	313,206	448,510	330,584
Ostmark[15]	30,070	29,100	32,845	30,000[1]	31,062	29,453	26,772	43,697	29,000[1]	34,259	33,609	46,666
Slovakia	12,158	10,731	10,960	10,159	9,333	11,015	10,933	13,747	10,502	9,879	10,546	9,000
Poland	327,077	315,768	324,803	315,381	314,000[1]	328,115	321,134	330,412	318,000[1]	326,000[1]	326,000[1]	290,000
Japan[10]	214,820	207,522	216,078	216,707	216,707	217,525	170,597	220,451	224,255	173,737	224,885	214,000
British India[11]	197,792	196,543	198,872	192,656	241,191	225,897	217,058	195,000[1]	198,000[1]	195,000[1]	195,000[1]	132,000
Ecuador	191,746	181,331	190,542	188,712	192,360	193,634	189,037	192,702	185,669	192,882	195,556	171,634
Saudi Arabia	2,622	2,382	3,794	3,477	3,550	3,459	40,556	136,947	152,632	139,038	155,605	170,865
Sarawak[12]	137,281	133,248	137,824	132,240	132,007	107,102	123,476	223,165	115,952	118,512	116,030	105,714
Egypt[13]	94,545	88,555	89,935	84,998	83,412	143,978	157,533	208,377	211,841	221,156	308,946	301,102
Italian Empire: Albania[16]	42,400	41,000	42,400	72,300	46,049	4,998	68,655	Nil	Nil	6,220	47,402	39,000
Italy	9,612	9,459	9,563	8,646	9,378	9,057	8,267	8,622	8,533	7,937	7,511	7,000
France	43,589	42,839	48,545	43,189	43,574	43,000[1]	41,104	42,296	40,797	48,000[1]	42,000[1]	40,000
Hungary	13,976	13,775	18,691	26,018	25,888	30,900[1]	38,240	49,800[1]	43,303	47,671	43,000	36,000
Bolivia[1]	9,100	8,800	9,000	8,790	9,500	9,200	8,500	8,800	8,500	9,000[1]	8,800	7,000
Other Countries[17]	6,000	5,800	6,000	5,800	6,000	6,000	50,000	48,000	50,000	48,000	50,000	35,000
WORLD TOTAL	171,623,617	157,966,520	162,969,847	158,595,448	165,873,160	171,234,333	163,034,936	168,976,728	163,553,563	168,151,310	167,891,195	153,725,343

[1] Estimated.
[2] Includes natural gasoline production
[3] International Petroleum Company and Lobitos Oilfields, Ltd. figures combined.
[4] Russian Sakhalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised—fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	Daily Av. Jan.-Feb. 1939	Jan.-Feb. 1939	Daily Av. Jan.-Feb. 1938	Jan.-Feb. 1938	Daily Av. 1938	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	3,321,440	195,965,000	3,401,678	200,699,000	3,323,984	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	584,712	34,500,000	529,457	31,238,000	564,909	206,192,000	201,856,661‡	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	532,014	31,388,806	492,616	29,064,381	475,360	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	228,814	13,500,000	208,846	12,321,928	214,577	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	103,372	6,098,957	89,196	5,262,560	94,625	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,928
Borneo	35,873	2,116,507	36,137	2,132,090	35,102	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	17,605	1,038,738	20,811	1,227,865	19,056	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	1,770	104,419	1,722	101,603	1,665	607,622	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	128,345	7,572,358	133,062	7,850,692	132,508	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	75,085	4,430,000	138,284	8,158,783	105,495	38,505,824	46,455,687‡	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	74,068	4,370,000	85,700	5,056,308	88,778	32,404,000	30,603,660‡	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	55,888	3,297,390	55,815	3,293,125	59,127	21,581,588	20,297,543‡	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	53,417	3,151,609	45,302	2,672,840	48,592	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	55,932	3,300,000	45,203	2,667,000	46,784	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	39,916	2,355,040	26,942	1,589,589	43,584	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Bahrein	21,335	1,258,754	25,647	1,513,179	22,734	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Burma	20,000	1,150,000	18,861	1,112,828	20,748	7,572,089	7,847,553	7,587,718	7,181,113	7,278,859	,114,311	7,073,437
Canada	15,047	887,782	14,755	870,566	19,004	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,412
Brunei	16,272	960,038	13,400	790,644	14,759	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Great Germany: Old Reich	14,391	779,094	8,915	525,995	10,548	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	1,360	80,275	911	53,780	1,014	370,038	221,266	50,092	44,347	27,965	5,765	804
Slovakia	331	19,546	364	21,507	362	132,045	122,790	126,603	136,580	177,797	121,695	126,603
Poland	10,440	616,000	10,375	612,160	10,489	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	7,438	438,885	3,945	232,785	6,880	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	5,543	327,000	5,404	328,861	6,281	2,292,524	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Ecuador	6,223	367,190	6,079	358,663	6,184	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	5,535	326,470	113	6,678	1,356	495,135	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	3,758	221,744	4,476	264,075	4,452	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	10,340	610,048	3,000	176,901	4,277	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
Italian Empire: Albania	1,464	86,402	1,383	81,600	1,199	437,597	380,292	219,693	41,218	17,500	11,437	9,212
Italy	246	14,511	288	17,017	291	106,083	112,700	129,653	128,615	162,449	213,534	242,563
France	1,390	82,000	1,400	82,400	1,414	516,240	507,067	534,063	529,664	700,000	786,366	755,146
Hungary	1,340	79,000	444	26,205	906	330,829	13,910	100	Nil	Nil	Nil	Nil
Bolivia	268	15,800	299	17,430	292	106,620	123,123	104,746	163,295	157,875	111,973	41,907
Other Countries	1,440	85,000	193	11,400	665	243,000	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	5,450,752	321,594,363	5,431,194	320,440,438	5,388,004	1,966,621,791	2,041,168,442	1,797,891,143	1,652,023,331	1,516,760,036	1,438,797,443	1,305,574,242

‡Preliminary.

L PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighed averages for individual countries

METRIC TONS

	March 1938	April 1938	May 1938	June 1938	July 1938	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Preliminary Figures Feb. 1939
United States	14,420,469	12,916,610	13,357,804	12,762,583	13,939,606	14,507,243	13,189,481	13,785,028	13,343,306	13,846,893	13,874,374	12,653,243
Soviet Union[4]	2,192,000	2,448,000	2,411,000	2,543,000	2,497,000	2,414,000	2,401,000	2,387,000	2,366,000	2,339,000	2,332,000	2,400,000
Venezuela	2,232,753	2,023,972	2,363,588	2,409,066	2,205,195	2,455,545	2,404,477	2,564,234	2,417,054	2,474,385	2,438,207	2,201,782
Iran[5]	1,095,647	937,768	922,528	766,064	706,120	775,208	750,824	943,864	955,040	876,168	940,000[1]	850,000
Netherland India: Sumatra	390,975	378,445	398,988	388,437	377,750	389,439	391,566	409,288	404,756	426,522	420,001	398,651
Borneo	149,588	141,775	143,124	135,995	142,549	130,294	143,607	150,752	146,310	149,602	149,741	134,354
Java[9]	86,385	85,850	90,460	82,798	78,535	70,387	64,754	70,285	515,160	71,095	71,852	67,576
Ceram	6,762	7,204	6,916	6,694	7,253	7,359	6,759	6,771	45,750	6,144	6,604	7,412
Roumania	570,239	558,362	568,874	548,139	561,775	556,415	534,475	550,000	525,232	541,884	537,111	496,658
Mexico*	591,150	316,082	368,886	380,773	425,219	482,171	507,212	491,862	460,025	481,823	367,000[1]	291,000
Iraq	364,344	347,948	312,771	355,803	376,415	379,395	351,508	326,086	324,503	312,734	323,797	262,151
Colombia	256,700	228,878	253,615	254,514	254,669	260,629	250,475	263,669	259,768	266,046	238,406	224,000
Trinidad	202,425	199,666	208,456	201,446	211,113	211,928	213,185	224,385	211,580	234,214	232,537	210,413
Argentina[1]	198,000	192,200	196,900	191,900	192,200	193,800	193,500	194,000	193,500	288,930	285,000	184,000
Peru[3]	195,383	171,759	178,010	172,745	168,725	176,006	167,718	177,893	172,805	175,667	166,281	146,286
Bahrein[6]	100,478	94,457	84,723	90,435	95,428	97,279	97,479	96,650	83,585	85,009	88,264	83,180
Burma[7]	91,765	87,796	92,275	93,797	90,309	88,068	86,101	87,800[1]	89,100[1]	87,800[1]	89,100[1]	70,000
Canada[8]	60,739	58,649	71,511	67,934	87,586	103,298	111,686	86,545	56,280	61,812	67,151	45,000
Brunei[8]	58,376	56,230	58,416	55,552	59,464	58,772	62,688	62,607	63,491	66,939	66,410	59,474
Great Germany: Old Reich[14]	51,517	49,314	47,485	47,075	49,897	45,007	47,256	47,788	45,865	45,111	47,562	47,614
Ostmark[15]	5,820	5,627	4,900	5,800[1]	4,634	4,394	3,994	6,519	5,600[1]	5,111	5,014	6,962
Slovakia	1,776	1,566	1,601	1,484	1,521	1,609	1,597	2,008	1,534	1,443	1,545	1,500
Poland	43,150	41,658	42,850	41,607	41,000[1]	43,287	42,366	43,590	42,000[1]	43,000[1]	43,000[1]	38,000
Japan[10]	30,586	29,518	30,750	30,839	30,839	30,955	24,277	31,376	31,913	24,724	32,003	30,000
British India[11]	27,308	27,136	27,357	26,599	33,300	31,174	29,968	27,000[1]	27,300[1]	27,000[1]	27,000[1]	18,000
Ecuador	27,175	25,175	27,004	26,743	27,262	27,412	26,791	27,310	26,314	27,336	27,715	24,325
Saudi Arabia	328	305	492	451	460	453	5,498	18,570	20,697	18,590	21,100	23,169
Sarawak[12]	18,001	17,472	18,072	17,340	17,309	13,913	16,191	16,150	15,204	15,540	15,214	13,868
Egypt[13]	13,516	12,660	12,642	12,151	11,924	20,583	22,521	29,789	30,285	31,617	44,390	43,045
Italian Empire: Albania[16]	6,200	6,060	6,200	10,790	6,873	746	10,247	Nil	Nil	41,674	7,075	5,600
Italy	1,194	1,175	1,188	1,074	1,164	1,125	1,027	1,071	1,060	986	933	900
France	6,104	5,999	6,798	6,048	6,102	6,000[1]	5,756	5,923	5,713	6,000[1]	5,900[1]	5,500
Hungary	1,808	1,782	2,418	3,366	3,349	4,000[1]	4,947	6,400[1]	5,602	6,167	6,000[1]	5,000
Bolivia[1]	1,140	1,110	1,130	1,100	1,200	1,160	1,000	1,100	1,000	1,130	1,100	900
Other Countries[17]	850	830	850	830	850	850	7,000	6,700	7,000	6,700	7,000	6,000
WORLD TOTAL	23,500,651	21,479,562	22,320,582	21,770,972	22,714,595	23,589,804	22,178,931	23,356,015	22,900,332	23,094,796	22,986,387	21,255,557

[10] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Nominal figure representing proportion to world total represented by: Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China
[18] Official Figures—Petroleos Mexicanos.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

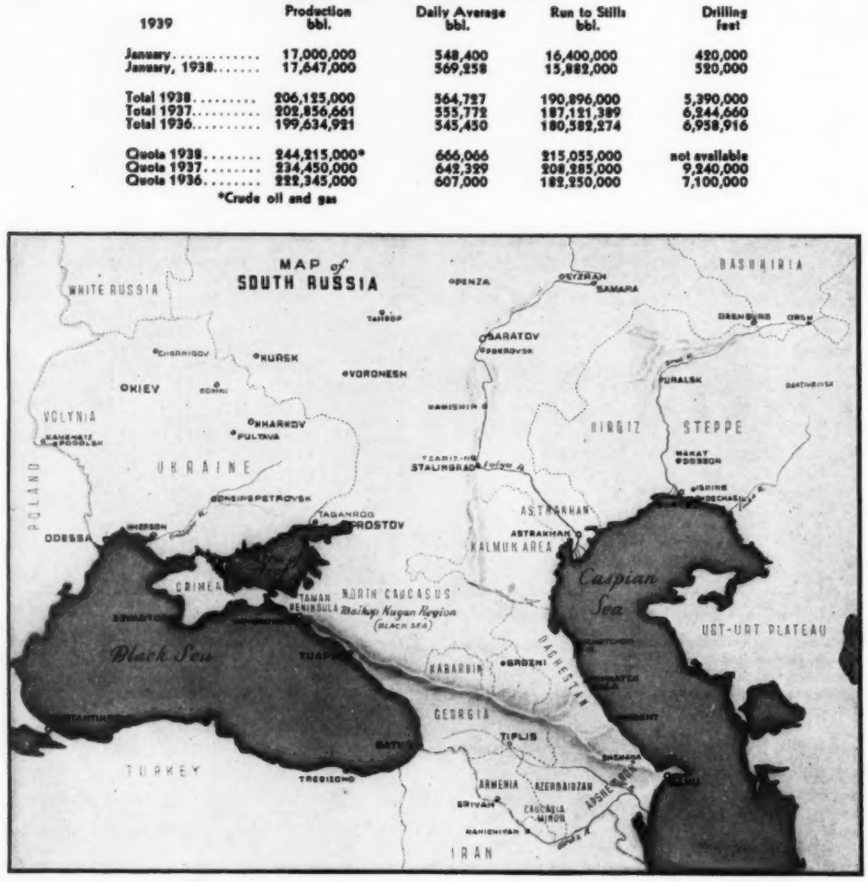
	Daily Ave. Jan.-Feb. 1939	Jan.-Feb. 1939	Daily Av. Jan.-Feb. 1938	Jan.-Feb. 1938	Daily Av. 1938	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	449,621	26,527,617	460,334	27,159,692	447,202	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	80,203	4,732,000	82,390	4,861,000	79,066	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	78,644	4,639,989	72,797	4,295,017	76,288	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	30,339	1,790,000	27,621	1,629,664	28,379	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	13,875	818,652	11,973	706,384	12,775	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	4,781	282,095	4,850	286,188	4,712	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	2,363	139,428	2,793	164,814	2,559	933,595	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	237	14,016	231	13,638	224	81,560	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	17,522	1,033,769	18,172	1,072,148	18,090	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	11,153	658,000	20,529	1,211,221	15,662	5,716,423	6,896,657‡	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	9,931	585,948	10,286	606,848	11,904	4,345,000	4,126,185‡	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	7,837	462,406	8,985	530,095	8,241	3,007,935	2,844,251‡	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	7,508	442,950	6,399	377,545	6,748	2,462,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	7,950	469,000	6,439	379,900	6,665	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	5,298	312,567	5,816	343,174	5,753	2,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	2,906	171,444	3,474	204,991	3,098	1,130,734	1,058,557	635,555	173,072	39,008	4,293	123
Burma	2,696	159,100	2,616	154,360	2,875	1,049,493	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	1,884	112,151	1,866	109,976	2,400	876,016	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	2,134	125,884	1,856	104,588	1,937	707,123	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	1,613	95,176	1,284	75,759	1,513	552,074	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	203	11,976	187	11,069	174	63,468	33,010	7,473	6,616	4,172	860	120
Slovakia	52	3,045	53	3,143	53	19,439	17,936	18,665	19,946	25,971	17,776	18,493
Poland	1,373	81,000	1,369	80,760	1,383	504,678	501,301	510,630	614,760	529,200	550,670	556,680
Japan	1,051	62,003	1,026	60,551	976	356,328	341,040	341,976	326,580	266,520	212,667	239,567
British India	763	45,000	770	45,404	868	317,004	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	882	52,040	862	50,831	876	319,877	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	750	44,269	15	839	183	66,683	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	493	29,076	592	34,934	548	200,126	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	1,482	87,435	430	25,370	611	223,058	166,298	177,491	176,436	214,671	232,437	265,055
Italian Empire: Albania	215	12,675	201	11,850	179	65,313	56,760	32,760	6,152	2,500	1,707	1,375
Italy	31	1,833	36	2,114	36	13,178	14,000	16,106	15,977	20,180	26,526	27,046
France	193	11,400	193	11,399	198	72,106	71,008	74,788	74,172	98,025	110,120	105,758
Hungary	186	11,000	61	3,598	120	42,798	13,910	13	Nil	Nil	Nil	Nil
Bolivia	34	2,000	37	2,192	36	13,262	15,487	13,197	20,540	19,858	14,085	5,284
Other Countries	220	13,000	27	1,620	93	34,080	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	746,423	44,039,944	756,570	44,632,676	742,425	270,984,151	279,495,814	240,539,340	226,410,486	207,970,753	197,024,849	179,181,741

U. S. S. R.

Official Figures for Soviet Oil Operation

1939	Production bbl.	Daily Average bbl.	Run to Stills bbl.	Drilling feet
January	17,000,000	548,400	16,400,000	420,000
January, 1938	17,647,000	569,258	15,882,000	520,000
Total 1938	206,125,000	564,727	190,896,000	5,390,000
Total 1937	202,856,661	555,772	187,121,389	6,244,660
Total 1936	199,634,921	545,450	180,582,274	6,958,916
Quota 1938	244,215,000*	666,066	215,055,000	not available
Quota 1937	234,450,000	642,329	208,285,000	9,240,000
Quota 1936	222,345,000	607,000	182,250,000	7,100,000

*Crude oil and gas



Russian Oil Survey—Part I

First of a Series Dealing With the Soviet Petroleum Industry in All Its Phases. This Article Outlines the Situation as a Whole, and Surveys in Detail the Baku Oilfields of the Caucasus. Subsequent Issues Will Deal With the Individual Subjects Summarized in the General Introduction. Next Month Mr. Wegrin Discusses Grozni.

INTRODUCTION

Oilfields—

Soviet oilfields are classified into two groups, Caucasian and those outside the Caucasus. From the former group comes 91 percent of the entire Russian output; Baku supplying 75 percent, Grozni 10 percent, and Maikop almost six percent. Ishembayevo is the most important producer outside of the Caucasus, with slightly more than three percent of the Soviet Union's production.

Soviet Oil Fields

CAUCASUS	EASTERN BASE	OTHER REGIONS
Baku	Ishembayevo	Turcoman
Grozni	Emba	Seghalin
Maikop	Aktiubinsk	
Daghestan	Sizran	
Crimea	Buguruslan	
Kuban	Prikama	
	Tulmazi	

What is referred to as the Eastern Oil Base is being developed north of the Caspian to act as a second Baku and to decentralize the production of the country.

Prospecting—

Considerable prospecting is under way in the Soviet Union; in Europe as well as in both northern and eastern Siberia. Oil search has extended to Kamchatka, north of Saghlin, in the east and to Ukutia in the Arctic Circle.

Refining—

The Soviet refining industry as reconstructed and expanded during the past decade embraces a total of 37 shell stills, 43 pipe stills, 23 lube oil manufacturing and treating plants, and 67 cracking installations, having an aggregate processing capacity of about 1,157,000 bbl. daily. Of these plants about 1,025,000 bbl. daily capacity, or 89 percent, are in the Caucasus. Another 5.5 percent (58,500 bbl. capacity) is situated along the Volga shores while a similar capacity is distributed over the various industrial areas, including Siberia, the Far East, and the Black Sea region.

Soviet Oil Refineries

LOCATION	NO. UNITS	BBL. DAILY CAP.
Baku	67	465,000
Grozni	43	373,000
Batum	12	96,000
Tuapse	5	52,000
Saratov	10	38,000
Krasnodar	3	22,000
Gorki Yaroslavl	9	20,400
Konstantinovka	..	.....
Orsk	3	17,500
Makhatch Kala	2	17,000
Ufa	2	12,000
Middleasia	4	11,000
Moscow	3	9,750
Odessa	2	5,800
Varinsk	1	5,700
Berdiansk	1	4,000
Kherson	1	4,000
Khabarovsk	1	3,000
Leningrad	2	1,750

Distribution—

The Soviet oil industry has to move about 28,500,000 tons of oil and petroleum products each year, of which 12,000,000 tons are carried by rail facilities, 10,000,000 tons by water transport, and 6,000,000 tons by pipelines.

There are evidently 15,000 rail tank cars in Soviet Russia, each with a carrying capacity of from six to ten tons, and some short haulages are also made by means of motor tank trucks. The tanker fleet consists of about 33 vessels with an aggregate capacity of 201,000 tons; most are fairly modern and the fleet has two main divisions, vessels for international trade and those plying Caspian waters only. The Russian oil industry also operates about 100 motor tank barges amounting to some 150,000 tons. About 75 tugs and similar vessels handle the 180 to 200 dumb barges of 300,000 to 350,000 tons in Caspian and Black Sea service.

Gathering lines in Soviet oilfields amount to 360 mi. at Baku, about 150 mi. in the Emba group, some 90 mi. at Grozni, 39 mi.

at Daghestan, and 24 mi. in Saghalin, or a total of 669 mi. Trunk lines from the various oilfields total 2,682 mi. built and 451 mi. under construction.

Consumption—

Consumption of petroleum products which in Soviet Russia is estimated at 23,850,000 tons per annum, and breaks down to the following divisions: gasoline, 5,000,000 tons; kerosene, 7,500,000 tons; Diesel and fuel oils, 8,500,000 tons; lubricating oil, 2,200,000 tons; asphalt and other products, 650,000 tons.

According to the last figures made available, only 14 percent of Soviet fuel requirements are supplied by oil—69 percent is obtained from coal, 11 percent from wood, five percent from peat, and the remaining one percent from shale and similar sources.

Soviet Exports and Gasoline Consumption in Tons

YEAR	TOTAL EXPORTS	GASOLINE EXPORTS	GASOLINE CONSUMPTION
1913	952,000	152,000	65,500
1924	712,000	275,000	45,000
1928	2,787,000	722,000	190,000
1929	3,625,000	980,000	225,000
1930	4,750,000	1,340,000	305,000
1931	5,212,000	1,660,000	625,000
1932	6,106,000	2,018,000	895,000
1933	4,890,000	1,296,000	1,165,000
1934	4,310,000	1,119,000	1,700,000
1935	3,353,000	658,000	2,300,000
1936	2,660,000	419,000	3,400,000
1937	1,930,000	350,000	4,200,000
1938 (9 months)	843,700	842,948*	not available

*All refined products.

Reserves—

Prof. I. Gubkin evaluates the explored and visible oil reserves of the U.S.S.R. immediately workable at 2,420,000,000 tons.

Workable Soviet Oil Reserves

AREA	TONS
Baku	1,250,000,000
Emba	640,000,000
Middleasia	240,000,000
Grozni	150,000,000
Maikop	80,000,000
Bashkiria	60,000,000

BAKU

THE Caucasus is the isthmus between the Black and Caspian seas, bounded in the north by Astrakhan, in the south by eastern Turkey and Iran, and having an area of 272,000 sq. mi. A range of mountains stretching 1,000 mi. from the Taman peninsula, Black Sea, with an elevation of 400 ft. and gradually ascends to as much as 18,500 ft. but declines into the Apsheron peninsula, on the Caspian; thus it is divided into north Causasia (or Circasia) and Transcausasus. The width of the range varies between 30 and 140 mi. and there are a only few passes.

Composition—

The Baku fields still center around the original pools. These have been reorganized and extended under the Azerbaidzan-Baku oil trust (Azneft) and are operated as the following main groups: Asisbekoff, Lenin, Stalin, Ordzonikidze, Kaganovitch, Artema (Holy) Island, Kirov, Kerges, Aliati, and Georgia. These groups also include the new

Map showing the Baku oilfields and main anticlinal axes of the Apsheron Peninsula, Russia.

fields prepared for exploitation during more recent years, such as Kala, Puta, Lokbatan. Several new regions are being developed, including the Apsheron peninsula, Kura river lowlands, Kabristan pastures, Kuban, the Shemakha-Shiraki region, Lenkoran (on the Iranian border), the promontory of Caucasus Minor, and other Georgian territory.

Physiography—

The Transcaucasian provinces are barren wastes where the formation of sulphurous gases must have contributed to the desolate and desertlike appearance. It is almost uninhabitable due to lack of water and vegetation. A few primitive roads over calcareous ground cut by boggy ravines connect the settlements. The main season for drilling is in the summer, when the heat is intense and there is no shade. The atmosphere is then oppressive, occasionally relieved by winds bringing dust storms which leave mounds of sand everywhere.

The petroliferous lands of the Transcaucasus are in a plateau, mostly flat lands on the recent geologically-formed elevations, and the oil deposits are seated deep in the hills flanking the heights. Long stretches along the Transcaucasian railroad up to Tiflis and along the Vladikavkaz railroad are denuded of any alluvial soil and devoid of vegetation. The plateau is about 270 ft. above sea level and the oilfields begin about eight or ten miles from Baku city, which is separated from its hinterland by a range of limestone. The plateau is sheltered in the northeast, east, south, and southeast by limestone rocks which overlie the oil horizons.

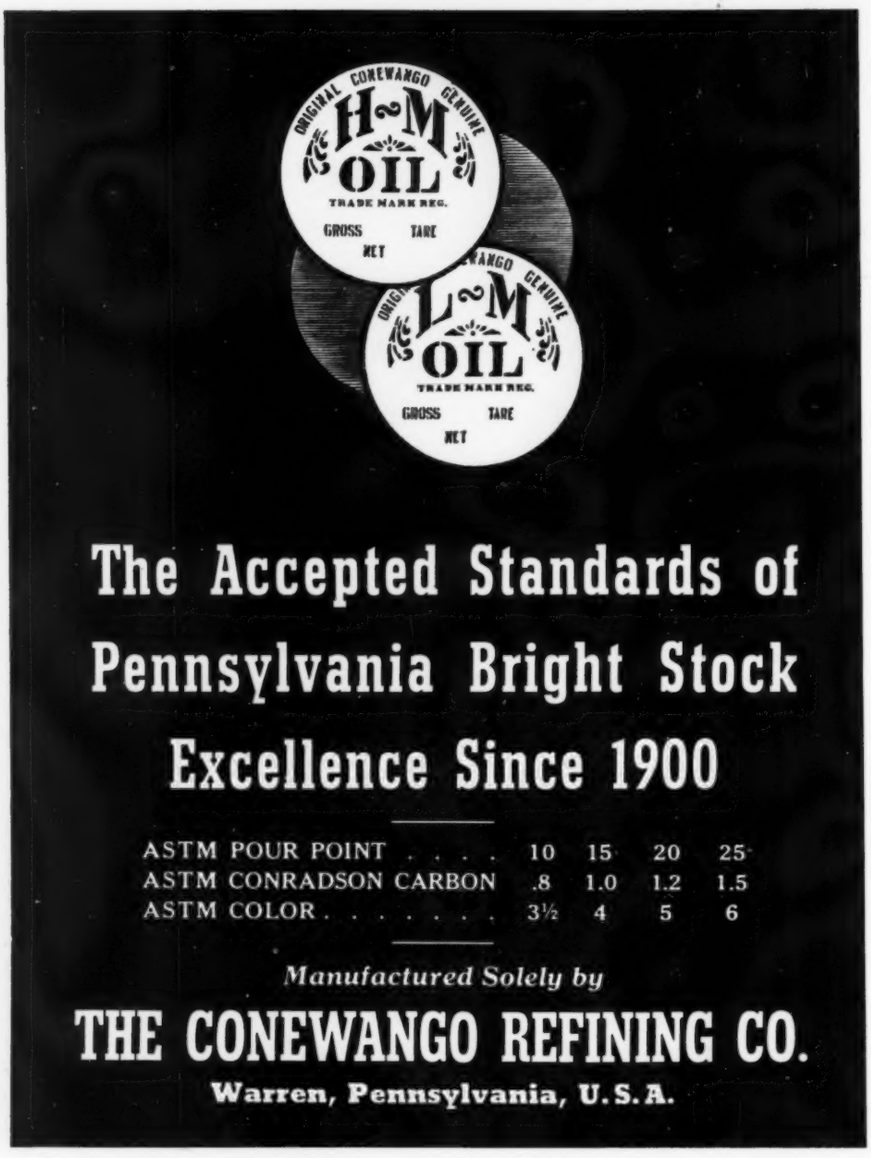
Stratigraphy—

The Azerbaidzan oilfields form a unique group; geologically they form a series of Tertiary strata in which oil is securely imbedded in consolidated clay and sandy clay which break easily when penetrated by the drill. The oil-bearing rocks are of Miocene and Oligocene ages. Apsheron is built up of Pleistocene and Tertiary rocks. Both Pliocene and Miocene rocks are well developed and the Upper Miocene carries the pay.

The formations consist mostly of Oligocene and Lower Miocene age, and beds compounded of yellow sands and fossiliferous limestone; other series are grey, blue-grey, and green-grey clays. These clays are often imbedded with laminae of fine sand. Some Baku clays were found to bear veins of skeletonized vegetable matter, but of insufficient quantity as to establish the species. The rather complex sands are classified as water, gas and oil sands; however, so-called dry sands have yielded oil, oil sands have proved dry, and water sands have given oil. The water sands are white and of a coarse sharp nearly transparent grain, resembling sea shore sands. Oil, gas, and dry sands are mostly smooth spherical pebbles, dark and odorous with traces of aeolian condition. These were the largest yielders in the original pools. When the aeolian fineness is increased the oil-content is diminished and only gas emanates. Much of the sand is mixed with iron in the form of a hard pyrite. There are also rounded masses of calcareous sandstone apparently smoothed by violent action of gas on the bottom under pressure.

The formations contain sulphide of iron, carbonaceous and calcareous matter, water and salt, the latter being characteristic of Russian oilfields.

Carbonates abound, while sulphates are rare both in rocks and in the connate waters, and the iron pyrites component shows that the deposits are likely below 1,200 ft.—the condition of the clay and mud corroborating. Apparently fluctuation in depth and distance from land must have taken place by the deposition of oil in the strata, and the water sand must have been a water deposit. The aeolian sands are most irregular in horizontal distribution as to size and character, and the regularity of the clay beds indicates that both were derived from the same source and distributed by a similar action.



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Surface Geology—

Where the strata reaches or approaches the surface, many manifestations are evident. All along the plateau where the old pools are situated, and in some of the new regions where the oil strata reach the surface at an acute angle, the outcrops and beds can be traced and each stratum can be identified by color, composition, oil seepage, salt water, gas and many other features. Some outcrops formed hills by effusion of gas and oil. Other places are dotted with mud volcanoes where in the course of time conical mounds of earthy material have been accumulated and the summit has formed a crater from which gas, mud, water and often oil are forced up by gas pressure. These hills occur at Binagadi, Hordlani, are abundant all over the peninsula and on many islands in the Caspian.

Along the railway line at various places the strata dip at an angle of 20 deg., overlaid by horizontal sedimentary stratified deposits at the base of which is an oil-saturated bed. These beds are immediately above the lower series but covered up by non-petroliferous sediments.

Subsurface Geology—

The oil formation should be older than elevation of the Caucasian range and perhaps oil was formed independent of the terrestrial phenomena which resulted in the upheaval of the mountain range. The anticlinal structure did not result in fracture of the beds and thus brought the deposits to workable depth. Undoubtedly the syncline may prove as prolific as the anticline but at greater depth. Gases from deeper strata may have found their way up but the oil situated deeper could not have migrated up. In migrating the oil penetrated into seams and moved along the seams filling up some parts, and some faulty fissures of upright beds were also found to have been covered by a flow of oil. In the Baku fields some 18 to 20 layers were found and operated at which gas layers were 25 ft. thick and oil layers 45 to 50 ft. thick with water up to 10 ft.

In the strongly-flowing wells of Baku, masses of detached strata loosened from the formation tapped are brought up under pressure from the hole, often in the form of compact pieces of dark sand which give up 15-25 percent of its bulk in oil and offers an opportunity for studying the characteristics of the ground, better than from drilling. Lumps of rock may come up the oil fissures and then loose sand may be thrown up which indicates that it has never been in a solid condition in the subsoil. These three types occur in the zones within short distances from one another and the amount of hydrocarbons may fluctuate from traces to 15 or 20 percent and as this varies so varies

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the presence of oil sand in compact form in one place and sandstone or sand in other places. Compact sands broken up by the drill are not large producers of oil as is also the case with rocks. Rocks may contain traces and up to three to four percent of oil, compact sands from 15 to 20 percent, but loose sands offer 30 to 50 percent of their volume in oil. The beds or zones are often separated by intervals of non-producing formations or gas formations or which are devoid of oil and gas. In the old pools of Baku 70 to 80 formations were found, Bibi Eibat had eight to ten strata and during recent years many more layers were discovered by deep drilling. The strata have no regularity of deposits, the occurrence is irregular and the depth cannot be foretold with precision.

Depth of oil sands vary considerably and often requires boring at an angle because of lenticular pockets which may vary in thickness. During recent years the subsoil was better studied which offers a better classification of the ground. Wells under regular production and deemed exhausted after some time were cleaned or deepened and gave producers of more or less importance, which is indicative of some sort of barriers which existed or of periodical migration. The migration of oil towards the properties is a remarkable feature, probably because the oil moved on to spots from which large quantities of sand were removed and to which areas of lower density the oil no longer driven by gas pressure has moved on by gravitation.

Since 1930 the Russian geological services have turned attention to geophysical methods. This was dictated by the reconstruction of drilling to rotary methods and the use of modern drilling bits. Research was also introduced to measure crookedness of drilling, the flow of water, and Schlumberger electrical prospecting was introduced.

Drilling and Production Technique—

There are some 7,500 to 8,000 oil wells in the Baku oilfields, of which 1,200 to 1,500 are shut down either for repairs or due to inadequate output. Many of this latter classification have recently been returned to service and have proven satisfactory producers. There are few dry holes.

The number of producers flowing naturally has been on the decline in Baku during recent years, and about 67 percent of the wells are under mechanical operation of some description. Some 4,000 wells are on the pump while about 1,500 wells are operated by use of compressors on the air lift and the more recently prevalent gas lift system. There are about 400 flowing wells, and the balance of the operating wells give production by bailing. Daily output by means of these different systems is approxi-

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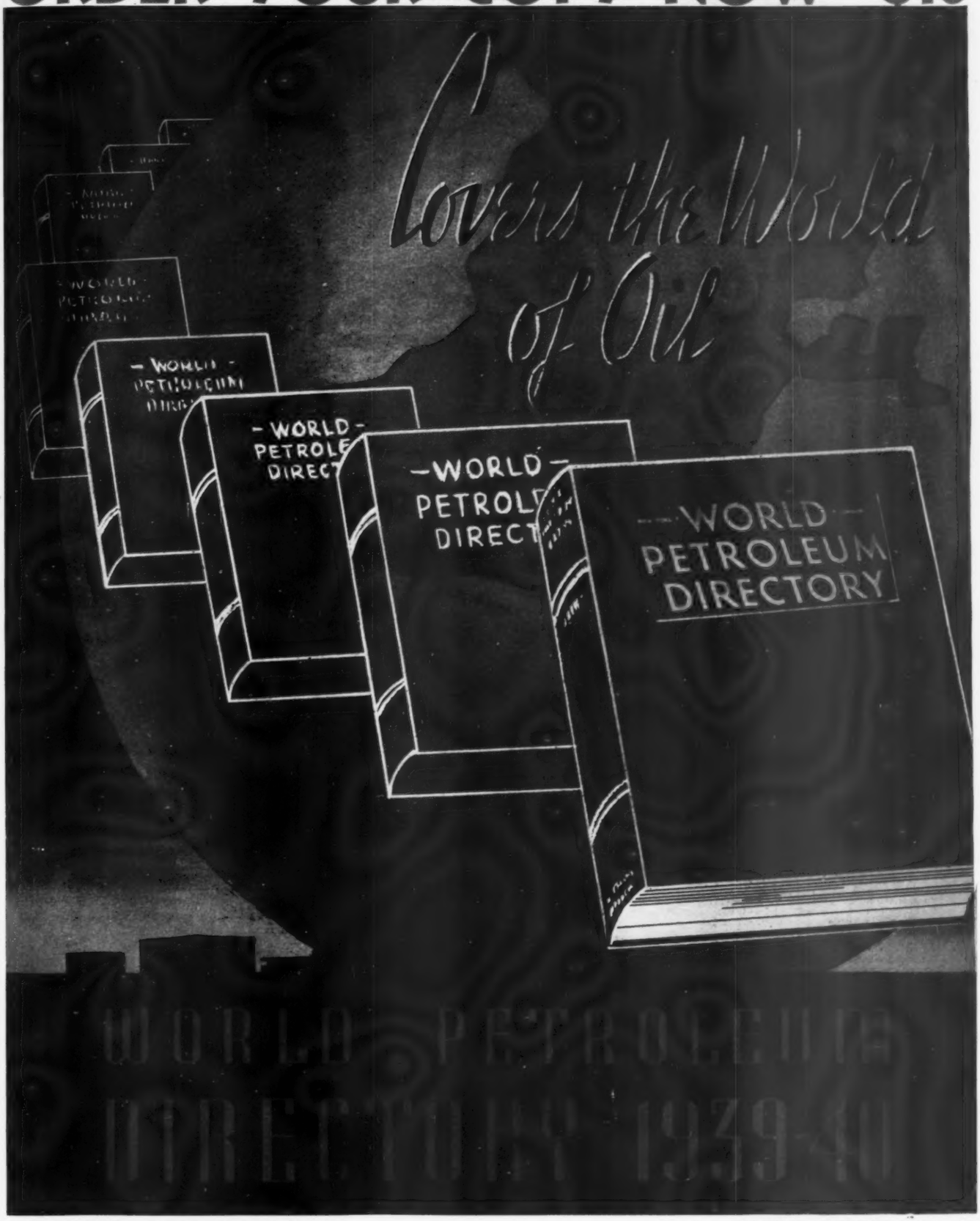

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mately 66 to 80 tons from flowing wells, 30 to 32 tons from compression, three-and-a-half tons by pumping and two tons by bailing. Of the total production from the Baku fields in 1938, about 54 percent is by bailing and pumping (of which 16 percent is from deep horizons), and 38 percent is by gas or air lift.

The upper oil sands at Baku are almost exhausted and it has been becoming necessary of recent years to drill to greater depths, even as much as 8,000 or 10,000 ft. The average depth at which oil is produced is between 2,500 and 3,500 ft., although there are a large number of producers between 4,000 and 5,000 ft. and a few between 1,000 and 1,500 ft.

Drilling Speeds in Baku Fields

Year	Ft./Table/Mo.
1913	272
1930	343
1931	373
1932	640
1933	825
1934	1,063
1935	1,164
1936	1,307
1937	1,531
1938	1,805

Most of the power used for drilling at Baku is electricity, although in the newer and undeveloped regions steam or gas engines are used.

Soviet Casing Programs in Baku Fields

	Well A		Well B	
	Diam.	Depth	Diam.	Depth
Surface string	18-20 in.	400 ft.	20 in.	400 ft.
1st water string	12-13 in.	1,600 ft.	11 in.	1,700 ft.
2nd water string	8-9 in.	2,300 ft.	8 in.	2,100 ft.
3rd water string	5-6 in.	3,000 ft.	5 in.	2,500 ft.

Speeds of 2,766 ft. per table month have been attained using a four-speed rotary table, with covered rotor, ordinary reduction gear, 100 h.p. electric motor, and two 6¾ in. by 14 in. pumps driven by 130 h.p. electric motors.

Transportation—

Two 600 mi. pipelines connect Baku to the export terminal at Batum, on the Black Sea, paralleling the main railroad line which is used chiefly for oil transport.

Well Spacing—

The sinking of as many as 4,000 wells in an area of 10 sq. mi. is a thing of the past in the Baku fields, and well-spacing is now according to the producing horizon tapped.

Well Spacing in the Baku Oilfields

Field	Horizon	Well per Hectare
Ordzonikidze	IV, IVa	1
	IV, V	1½
	Va and lower	2
Stalin	V to VIII	1
	XV to XVII	2
	Below XVII	4
Karachukhur	VII and above	1
Artema Island	All depths	1
Puta, Karpez and Shubani	All depths	1
Neftechala	All depths	1½
Kirov	All depths	1

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